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COMPARISON AND INTERPRETATION ON A CALORIC BASIS OF THE MILK MIXTURES USED IN INFANT FEEDING*

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NEW HAVEN, CONN.

Great progress in the study of nutrition has been brought about within the past two decades by new procedures in the feeding of experimental animals, particularly small animals. In earlier investigations, complex foods as they occur in nature were used, and important nutritive factors were often more or less unknowingly modified. In the more recent work, test rations of relatively simple foodstuffs, the proximate composition of which is known, are fed and the ensuing effect on the health and nutrition of the animals correlated with the variable or variables in the diet being studied. In this way, the rôle of certain nutrients in metabolic processes has been perceived. The method has reached its greatest refinement in the hands of Osborne and Mendel who, in their experiments on the rat, have employed "synthetic" diets of salts, vitamins and purified protein, carbohydrate and fat.

The adoption in infant feeding of the fundamental principles underlying the new method of approach in the study of nutritional problems would seem to promise fruitful developments; needless to say, application of the technic is more difficult with babies than with animals. However, some progress in this direction has been made in the Pediatric Clinic of Yale University. One of the necessary preliminary steps was to find out what the milk mixtures commonly used in infant feeding are when their constitution is expressed in terms of their actual nutrients independent of the medium, water, in which they are carried. Accordingly, the energy yielding food components were estimated in terms of their respective proportions of the total caloric value of the food mixtures as fed. This expression of the milk mixtures in terms of the unit of physiologic currency—the calory—has brought to light certain interesting and significant facts which will be described and discussed.

CURRENT DIETETIC METHODS OF EVALUATING FOODS

Foods are evaluated and compared in various ways according to the basic units used. The unit may be some other foodstuff or food component arbitrarily selected as a standard. More frequently, however, a

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* From the Department of Pediatrics, Yale University, School of Medicine.

gravimetric standard, the ounce or gram, or the unit of energy, the calory, is employed.

The scientific use of food equivalents in dietetics has been largely limited to animal husbandry where the starch unit of food value is frequently used. Borrowing from the stockman's method, Pirquet developed a food unit system of dietetics for human beings and coined the term "nem" which he used as the unit of currency for food values. The expression of the nutritional value of all foods as multiples or fractions of the nutritive combustible value of 1 gm. of human milk of average composition (the "nem") may have great psychologic assets under certain circumstances, but the scientific value of the method is questionable. Physicians frequently illustrate to their patients the worth of various foods by comparing their nutritional value with that of an egg; the "nem" is helpful in just the same way.

The "formulas" of the food mixtures used in infant feeding are ordinarily expressed as the proportions by weight or volume, which the various food components are of the total mass of the food—the so-called "percentage system." So formulated, certain similarities and differences in foods may be suggested in a vague way but the essential fact inherent in "the percentage system," namely, that the values of the nutrients are ratios which express only degree of concentration, is often lost sight of. For comparative purposes, especially, it is difficult to perceive significant facts from small, often fractional, percentage values of protein, carbohydrate and fat which shift with changes in volume. More helpful data would be apparent if water were disregarded and the food constituents were expressed as proportions of the solids in the mixture. Protein, carbohydrate, fat and salts would then be shown as they are related to each other independent of their relation to the diluent. These points may be made clear by a simple example, as shown in the table.

Composition of Cow's Milk and Diluted Cow's Milk

	Percentage of Volume		Percentage of Solids	
	Cow's Milk	Cow's Milk and Water, Equal Parts	Cow's Milk	Cow's Milk and Water, Equal Parts
Protein	3.5	1.75	28	28
Carbohydrate	4.75	2.37	38	38
Fat	3.5	1.75	28	28
Salts	0.75	0.37	6	6
Solids	12.5	6.2	100	100
Water	87.5	93.73	700	1,500

If cow's milk, containing 3.5 per cent. protein, 3.75 per cent. carbohydrate, 3.5 per cent. fat, 0.75 per cent. salts, 12.5 per cent. total solids, and 87.5 per cent. water is diluted with an equal volume of water, the mixture contains 1.75 per cent. protein 2.37 per cent. carbohydrate, 1.75 per cent. fat, 0.37 per cent. salts, 6.2 per cent. total solids and 93.75 per cent. water. The emphasis is here not obviously on the essential difference in the two mixtures, namely, that the second contains about twice as much water as the first but rather on the apparent differences in the comparative amounts of protein, carbohydrate and fat. As a matter of fact, in both mixtures the protein, carbohydrate and fat

are 28, 38 and 28 per cent. respectively, of the total solids, whereas the water in the second mixture (1,500 per cent. of the total solids) is approximately twice that in the first (700 per cent. of total solids). In this manner the actual comparative difference in the two mixtures is indicated to be exactly where it actually is, that is, in concentration. The energy yielding components do not appear to be affected relatively, as indeed they are not.

Although it is possible to establish a satisfactory means of comparative study of various foods on a quantitative basis, it is advisable to go further to a more fundamental unit for a common currency in infant feeding. The calory is the unit used everywhere by physiologists in the investigation of problems of nutrition. Itself a measure of energy, the calory is used constantly in metabolism studies and is also a physiologic unit. As such, it is greatly superior to the gram as the unit to which the protein, carbohydrate and fat food components may be reduced. The calory is a least common denominator of all energy-yielding food constituents and their derivatives. In this paper the caloric values of these derivatives have not been determined but it should not be thought that qualitative differences in the food constituents are considered unimportant, simply because interest is first directed to the relatively simple study of each of the three large groups of foodstuffs.

Briefly stated, in the analyses and comparisons of milk mixtures described in this paper, the total caloric value of a given amount of the food as fed is estimated, and the percentage relationships which exist between the total calories and the calories of protein, of carbohydrate and of fat are then determined. Thus, the energy yielding components are expressed and compared without confusing alliances with volumetric data.

Although a study of the protein, carbohydrate and fat components of food mixtures only is made in this paper, constituents which alone may be studied on a caloric basis, and emphasis has been placed on this method of approach, no undervaluation is implied of the importance in nutrition of water, vitamins and salts which are also food components.

EFFECT ON THE PROPORTION OF THE TOTAL CALORIES IN NUTRIENTS WHEN WATER OR ENERGY YIELDING FOOD COMPONENTS ARE ADDED TO MILK MIXTURES

The addition of water to any food mixture does not, of course, change the quantitative or calory relationships of the food components to each other. In whole cow's milk, for example, 22 per cent. of the total calories are in protein, 29 per cent. in lactose and 49 per cent. in fat (Chart 1). If water is added to whole cow's milk, the caloric value of each cubic centimeter of the mixture is thereby reduced but the proportions of the food components in the total energy valuation remain the same.

A very different result, however, is obtained when milk is "diluted" not with water, but with an energy yielding substance. The effect is to increase the value of the added component at the expense of those components which are unreinforced. The effect is shown in Chart 1. Carbohydrate, for example, when added in increasing amounts to a fixed volume of whole cow's milk, assumes an increasing percentage representation in the total energy value of the mixture at the expense of every other food component, protein, fat and lactose. These are "squeezed," as the chart suggests, by the added carbohydrate to smaller and smaller percentages of the total caloric valuation.

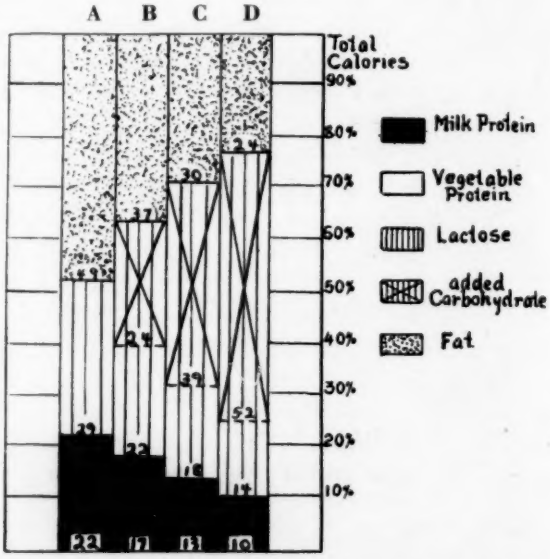

Chart 1.—Effect on the percentage of total calories in protein, carbohydrate and fat when various amounts of cane sugar are added to whole cow's milk: *A*, whole cow's milk, calories = 0.66 per c.c.; *B*, whole cow's milk, cane sugar, 5 per cent., calories = 0.86 per c.c.; *C*, whole cow's milk, cane sugar, 10 per cent., calories = 1.04 per c.c.; *D*, whole cow's milk, cane sugar, 17 per cent., calories = 1.32 per c.c. In each chart, the heavy black indicates milk protein; white, vegetable protein; straight lines, lactose; crossed lines, added carbohydrates, and dots, fat.

By subtraction, so to speak, of certain food components from mixtures, a reverse effect on the percentage representation of the other components in the total calories occurs. This is shown in Chart 2. If all the fat is removed from cow's milk (as in skimmed Cream-On), the percentages of the total calories in protein and lactose double their values in whole milk. If the milk has only part of its fat "subtracted" as in Dryco, then the percentage of the total calories in protein and lactose are also increased over their corresponding values in whole milk but not to the same degree as in fat-free milk.

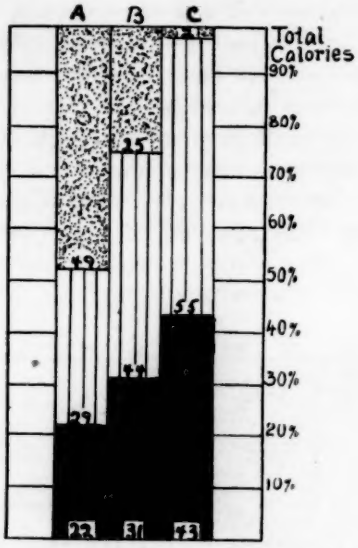

Chart 2.—Effect on the percentage of total calories in protein carbohydrate and fat when various amounts of fat are removed from cow's milk: *A*, whole cow's milk, calories = 0.66 per c.c.; *B*, Dryco, 1 part, water, 10 parts, calories = 0.42 per c.c.; *C*, skimmed Cream-on, 1 part, water, 10 parts, calories = 0.32 per c.c.

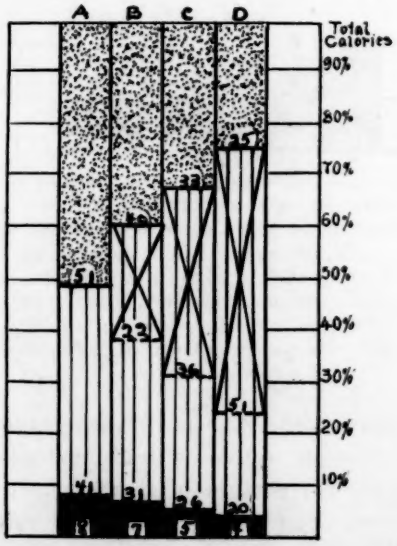

Chart 3.—Effect on the percentage of total calories in protein, carbohydrate and fat when various amounts of sugar are added to human milk: *A*, human milk, calories = 0.72 per c.c.; *B*, human milk, cane sugar, 5 per cent., calories = 0.92 per c.c.; *C*, human milk, cane sugar, 10 per cent., calories = 1.12 per c.c.; *D*, human milk cane sugar, 18 per cent., calories = 1.44 per c.c.

The effect of the addition of an energy yielding substance like sugar to breast milk is shown in Chart 3. In breast milk, 8 per cent. of the total energy is in protein. As sugar is added, the protein, lactose and fat proportions of the total calories become smaller and smaller. When isodynamic amounts of sugar (18 per cent.) are added to human milk, protein constitutes only 4 per cent. of the total calories. The vitamins, salts and unknown factors are also proportionately reduced by the addition of sugar. Thus, this mixture, used particularly by Schick for premature and for feeble infants is probably not a safe food for use over any considerable period of time.

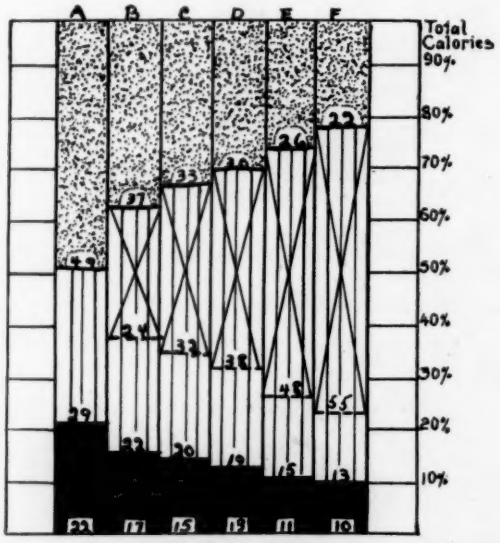

Chart 4.—Effect on the percentage of total calories in protein carbohydrate and fat when cane sugar in amount equivalent to 5 per cent. of the mixture is added to various dilutions of cow's milk with water: *A*, whole cow's milk, calories = 0.66 per c.c.; *B*, whole cow's milk, cane sugar, 5 per cent., calories = 0.86 per c.c.; *C*, whole cow's milk, 2 parts; water, 1 part; cane sugar, 5 per cent., calories = 0.62 per c.c.; *D*, whole cow's milk, 1 part; water, 1 part; cane sugar, 5 per cent.; calories = 0.53 per c.c.; *E*, whole cow's milk, 1 part; water, 2 parts; cane sugar, 5 per cent., calories = 0.42 per c.c.; *F*, whole cow's milk, 1 part; water, 3 parts; cane sugar, 5 per cent., calories = 0.36 per c.c.

When carbohydrate is added at a fixed percentage of the total volume to various water dilutions of cow's milk, the general effect on the distribution of calory percentages is identical with that demonstrated in the foregoing when carbohydrate is added in varying percentages of the total volume to undiluted cow's milk or to human milk (Chart 4). That is, as the mixtures in the series are made increasingly dilute while the volumes are kept the same, the percentage values in the total calories of protein, lactose and fat become progressively smaller, whereas that of the carbohydrate, always added in the same proportion

of volume, becomes progressively larger. Thus, the addition of an energy yielding nutrient, such as sugar, at a fixed proportion of the total volume of mixtures identical in volume but containing diminishing amounts of energy yielding milk and increasing amounts of water, has the effect of actually adding to the mixtures relatively increasing amounts of sugar. On the other hand, if in the same water dilutions of milk, the ratio between the decreasing amount of milk and the added sugar is always the same, the percentage relationship of protein, fat, lactose,

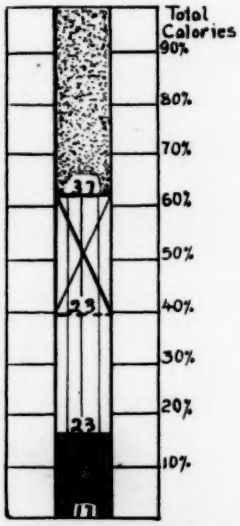

Chart 5.—Unaffected percentage of total calories in protein carbohydrate and fat when cane sugar in amount equivalent to 5 per cent. of the milk in mixture is added to dilutions of cow's milk: whole cow's milk, cane sugar, 5 per cent. of milk in mixture, calorie = 0.86 per c.c.; whole cow's milk, 2 parts; water 1 part, cane sugar 5 per cent. of milk in mixture, calories = 0.56 per c.c.; whole cow's milk, 1 part, water, 1 part, cane sugar, 5 per cent. of milk in mixture, calories = 0.43 per c.c.; whole cow's milk, 1 part, water, 2 parts, cane sugar, 5 per cent. of milk in mixture, calories = 0.28 per c.c.; whole cow's milk, 1 part, water, 3 parts, cane sugar, 5 per cent. of milk in mixture, calories = 0.21 per c.c.

and added carbohydrate in the total calories will be unaffected by water dilution. This is shown in Chart 5 where the added carbohydrate in the formulas is always 5 per cent., not of the volume of the mixture, but of the milk therein.

COMPOSITION AND COMPARISON OF MILK MIXTURES WHEN THE ENERGY YIELDING COMPONENTS ARE EXPRESSED IN PERCENTAGES OF TOTAL CALORIES IN MIXTURES

With this preliminary discussion of some of the facts of general interest brought out by the method of food evaluation used in this study,

a comparison and interpretation of the mixtures commonly used in infant feeding will now be made.[1]

Whey-Adapted Milk of Schloss ‡

Whole milk	140.0 c.c.
Cream (20%)	140.0 c.c.
Nahrzucker	35.0 gm.
Flour	15.0 gm.
Nutrose	5.0 gm.
Water	700.0 c.c.

Calories = 0.6 per c.c.

Nine per cent. of total calories in protein, 49 per cent. in carbohydrate and 42 per cent. in fat. (Composition of cream:† protein, 3 per cent.; lactose, 3.9 per cent.; fat, 20 per cent.).

Artificial Mother-Milk of Friedenthal ‡

Water	600.0 c.c.
Skimmed milk	330.0 c.c.
Milk sugar	58.0 gm.
Cream, q. s. to make a mixture containing 4.5 per cent. fat (If 16 per cent. cream is used, the required amount is 364.0 c.c.)	

Calories = 0.96 per c.c.

Nine per cent. of total calories in protein, 37 per cent. in carbohydrate and 54 per cent. in fat. (Composition of skimmed milk:* protein, 3.2 per cent.; lactose, 4.5 per cent., and fat, 0 per cent. Composition of cream,* protein, 3.2 per cent.; lactose, 4.5 per cent., and fat, 16 per cent.).

Composition of Foods in Gravimetric Percentages

Food	Protein	Carbohydrate	Fat	Calories per 100 C.c. or Gm.	Per Cent. of Total Calories in: Protein	Carbohydrate	Fat
Breast milk	1.5	7.3	4.0	72	8	41	51
Cows' milk	3.5	4.7	3.5	66	22	29	49
Asses' milk *	1.8	6.1	1.3	44	16	57	27
Ewes' milk *	5.6	5.0	7.0	105	21	19	60
Reindeer milk *	10.9	2.8	17.1	207	21	5	74
Mares' milk *	2.5	5.8	1.1	43	23	54	23
Goats' milk *	4.6	4.3	4.0	71	25	25	50
Sows' milk *	7.2	3.2	4.5	83	35	15	50
Eagle Brand condensed milk *	8.0	54.9	9.6	338	10	65	25
St. Charles evaporated milk *	8.8	10.9	8.7	157	22	28	50
Whey (König)†	0.8	4.7	0.3	25	13	76	11
Dryco	33.3	45.9	12.0	424	31	44	25
Klim (whole)	27.0	38.0	28.0	512	21	30	49
Mammala	24.0	54.0	12.0	420	23	51	26
Cream-On (skimmed)	39.0	49.6	0.5	359	44	55	1
Protein milk ‡	2.7	1.4	2.2	37	30	16	54
Mellins Food	10.3	79.5	0.1	359	11	89	..
Malt soup extract (Borcherdt)	6.4	69.2	....	302	8	92	..
Gaertner's milk §	1.7	6.5	3.5	64	11	41	48
Backhaus milk §	1.6	6.0	3.1	58	11	41	48
Ramogen	7.0	34.6	16.5	314	9	44	47
Meigs mixture [5]	1.2	6.6	3.5	62	8	42	50
Rotch formula [5]	1.1	6.2	4.0	65	7	38	55
Lahmann's vegetable milk §	10.0	38.5	25.0	419	9	37	54

* Morse, J. L., and Talbot, F. B.: Diseases of Nutrition and Infant Feeding, Ed. 2, New York, The Macmillan Company, 1920.

† Holt, L. E., and Howland, J.: The Diseases of Infancy and Childhood, Ed. 7, New York, D. Appleton & Co., 1916.

‡ Finkelstein, H.: Lehrbuch der Säuglingskrankheiten—Zweite Auflage, Berlin, J. Springer, 1921.

§ Fischer, L.: Infant Feeding in Health and Disease, Ed. 2, Philadelphia, F. A. Davis Company, 1901.

1. The data on which the study is based are summarized on the charts or in the tables which follow. The approximate physiologic fuel values of the food constituents were used, that is, protein, 4 calories per gram, carbohydrate, 4 calories per gram, and fat, 9 calories per gram. The fat content of butter was counted as 85 per cent. The protein content of wheat flour was counted as 10 per cent. (Sherman, H. C.: Chemistry of Food and Nutrition, Ed. 2, 1920, New York, The MacMillan Co.)

In Chart 6, the caloric evaluations of the milks of several species of animals are graphically shown, arranged in an ascending scale with reference to the protein percentage values in the total calories. The protein of human milk is markedly lower than that of any animals studied. The proportions of the total calories in protein of the milks of the sheep, reindeer, cow, horse and goat are strikingly similar, but the concentration of these milks varies greatly. It is noteworthy that the fat in the milk of the reindeer constitutes 74 per cent. of the total caloric value and the milk is highly concentrated; it has a caloric value of

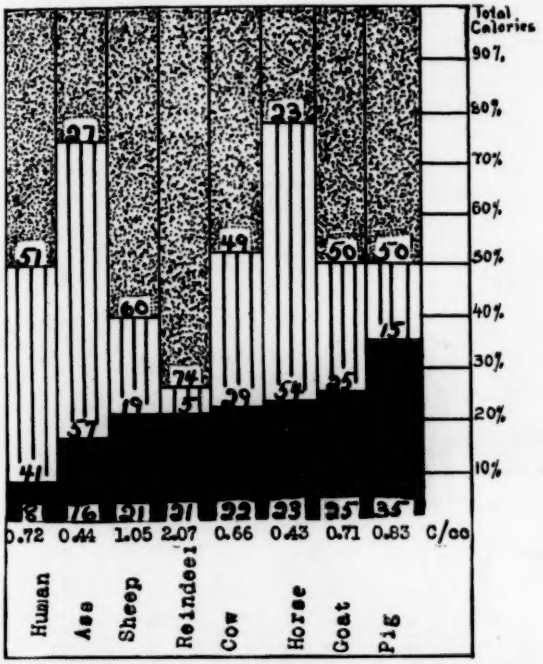

Chart 6.—Percentage of total calories in protein, carbohydrate and fat in the milk of animals of different species.

2 per cubic centimeter. No food used in infant feeding closely approaches reindeer's milk in this respect; the butter-flour mixtures of Moro represent the extreme point at present attained in concentration of milk mixtures fed to infants; in the foods described by Moro,[2] however, the caloric value is only about 75 per cent. of that of reindeer's milk. It is of interest to observe that of the milks of the various animals studied, no two, excepting those of the cow and of the goat, are similar in proportionate caloric configuration. As will be pointed out later, the

2. Moro, E.: Buttermehlbrei und Buttermehlvollmilch als Säuglingsnahrung. Monatschr. f. Kinderh. **18**:97, 1920.

caloric percentage pattern of ass's milk is more nearly that of the milk mixtures commonly used in infant feeding than is that of any other natural milk.

In Chart 7 a series of infant foods and milk mixtures is shown, arranged also according to the ascending scale of the values of the protein percentages of the total calories. Breast milk is at one extreme and skimmed cow's milk at the other. It will be obvious from the analyses

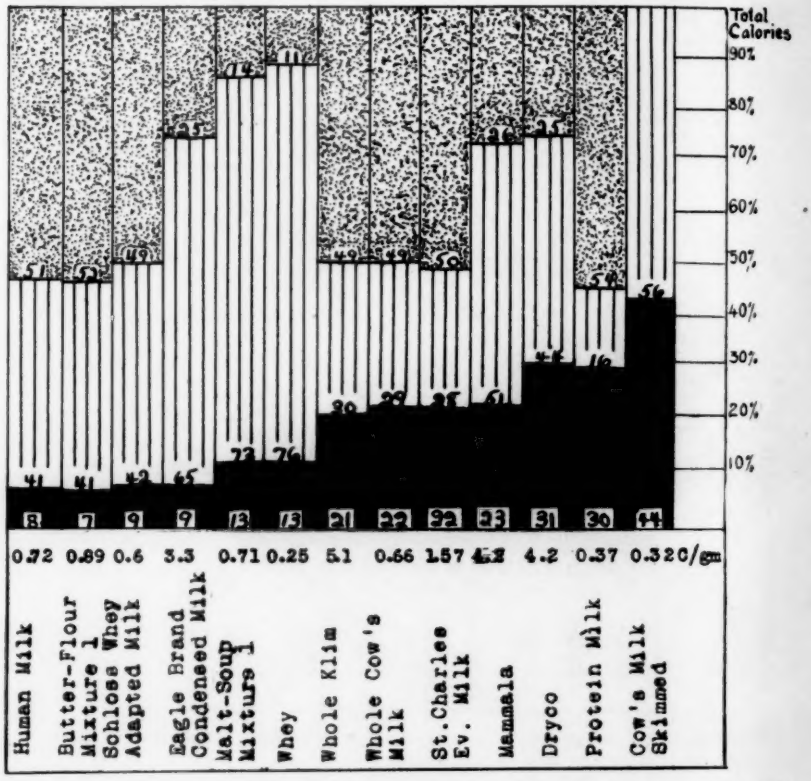

Chart 7.—Percentage of total calories in protein, carbohydrate and fat in several commonly used foods and feeding mixtures.

shown and graphically demonstrated in this paper that the mixtures studied fall rather readily into seven fairly well defined groups (Chart 8).

HUMAN MILK

Group 1.—Here the percentage representation in the total calories of protein, carbohydrate and fat are approximately 8, 41 and 51 per cent., respectively (Chart 3). Low protein combined with high fat is the outstanding characteristic of breast milk and no mixtures surpass it in

respect to this combination. In this group are the butter-flour mixtures,[3] most of the top milk mixtures with added sugar, most of the Winters,[4] Rotch and Meigs [5] mixtures, Ramogen and the avowed imitations of human milk—artificial mother's milk of Gaertner,[6] Backhaus,[6] Friedenthal,[7] whey-adapted milk of Schloss,[7] and synthetic milk adapted of Gerstenberger and Ruh.[8] Excepting these modifications of cow's milk, which, after all, are either obsolete or restricted in their use, breast milk has no following among the mixtures used in infant feeding. It stands alone among the vast majority of the successful mixtures, the caloric configuration of which is fashioned after a very different

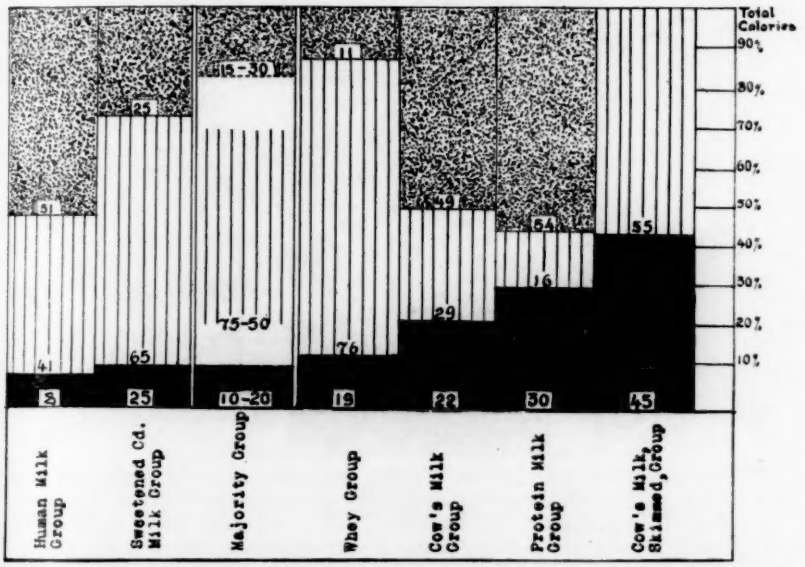

Chart 8.—Groups into which the milk mixtures commonly used in infant feeding may be assembled according to the similarity in their percentage distribution of protein, carbohydrate and fat in the total calories.

pattern from that of low protein, high fat and moderate carbohydrate. Quite the contrary result might have been anticipated and this method of analysis has revealed in a striking manner the uniqueness of breast

3. Czerny, A., and Kleinschmidt, H.: Ueber eine Buttermehlnahrung für schwache Sauglinge, Jahrb. f. Kinderh. **87**:1, 1918.

4. Winters, J. E.: Feeding in Early Infancy, Med. Rec. **63**:366, 1903.

5. Rotch, T. M.: Infant Feeding — Weaning, Keating's Cyclopaedia of the Diseases of Children. Vol. 1, Philadelphia, J. B. Lippincott Company, 1889.

6. Fisher, L.: Infant Feeding in Health and Disease, Ed. 2, Philadelphia, F. A. Davis Co., 1901.

7. Finkelstein, H.: Lehrbuch der Säuglingskrankheiten Zweite Auflage, Berlin, J. Springer, 1921.

8. Gerstenberger, H., and Ruh, H. O.: Studies in the Adaption of an Artificial Food to Human Milk, Am. J. Dis. Child. **17**:1 (Jan.) 1919.

milk. Human milk stands apart from the commonly used infant feedings, indeed, more conspicuously so than does cow's milk itself, in spite of the endeavor of most pediatricians to approach as near as possible to the one and to flee as far as possible from the other. A study of Chart 9 shows that all [9] of the so-called butter-flour mixtures of Czerny and Kleinschmidt [3] and Moro [2] are essentially foods having the percentage caloric apportionments to protein, carbohydrate and fat of human milk; regardless of variations suggested by their diverse

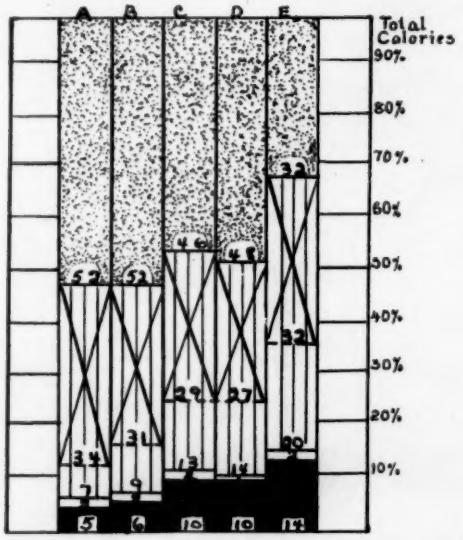

Chart 9.—Various butter-flour mixtures expressed in terms of the percentage of total calories in milk protein, vegetable protein, carbohydrate and fat: *A*, butter-flour food I (Czerny-Kleinschmidt), butter, 4.6 gm., wheat flour 4.6 gm., cane sugar 3.3 gm.; whole cow's milk, 33 c.c., water, to 100 c.c., calories = 0.89 per c.c.; *B*, butter-flour food II (Czerny-Kleinschmidt), butter, 4.2 gm., wheat flour, 4.2 gm., cane sugar 3.0 gm., whole cow's milk, 40 c.c., water to 100 c.c., calories = 0.87 per c.c.; *C*, butter-flour mixture (Moro), butter, 5.0 gm., wheat flour, 7.0 gm., cane sugar, 5.0 gm., whole cow's milk, 100 c.c., calories = 1.52 per c.c.; *D*, whole milk butter-flour mixture (Moro), butter, 5.0 gm., wheat flour, 3.0 gm., cane sugar, 7.0 gm., whole cow's milk, 100 c.c., calories = 1.44 per c.c.; *E*, fat rich milk mixture (Kleinschmidt), butter, 3.5 gm., wheat flour, 3.5 gm., cane sugar 5.0 gm., Sk. buttermilk, 100 c.c., (fat, 0.5 per cent.), calories = 1.0 per c.c.

formulas the mixtures differ almost entirely only in concentration. It is doubtful, however, if these mixtures were devised in any way as imitations of human milk, for they were adopted officially by pediatricians from the experience of Alpine peasants.[10]

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9. The Kleinschmidt (Monatsch. f. Kinderh. **19**:369, 1920-1921) modification is an exception to this statement; it is really sour whole cows' milk, with 8 per cent. carbohydrate added in the form of sugar and flour.

10. Personal communication of Professor Feer of Zurich to Dr. E. A. Park.

COW'S MILK

Group 2.—In this group the percentage representation in the total calories of protein, carbohydrate and fat is approximately 20, 30 and 50 per cent., respectively. Cow's milk, evaporated milk, Cream-On, full strength Klim and goat's milk belong in this group. There appears to be no widely used infant feeding mixture which is actually an imitation, conscious or otherwise, of cow's milk; the tendency has always been away from unmodified cow's milk although it has been fed successfully to many infants. From the experience of Budin and his followers, there can be no doubt that sterilized whole cow's milk can

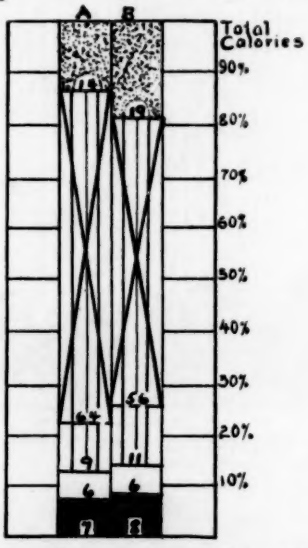

Chart 10.—Two malt-soup mixtures expressed in terms of the percentage of total calories in milk protein, vegetable protein, carbohydrate and fat: *A*, wheat flour, 5.0 gm., malt-soup extract, 10.0 gm., whole cow's milk, 33.0 gm., water 100 c.c., calories = 0.71 per c.c.; *B*, wheat flour, 5.0 gm., malt-soup extract, 10.0 gm., whole cow's milk, 50.0 gm., water 100 c.c., calories = 0.83 per c.c.

be successfully fed to some infants. That it is not extensively used is testimony, however, to the fact that it is not the most easily tolerated artificial food for infants.

WHEY

Group 3.—Here the percentage representation in the total calories of protein, carbohydrate and fat is approximately 13, 74 and 13 per cent., respectively—about three fourths of the calories being in carbohydrate and the remainder about equally allotted to protein and fat. The removal of the casein and enmeshed fat in the preparation of whey has the same effect on the caloric constitution of the mixture as that of adding 15 per cent. carbohydrate to half-skimmed milk. Many familiar

friends are found in this group, the most prominent of which are the malt-soup mixtures (Chart 10). Nestle's Food, Horlick's Malted Milk and Eskay's food (when used without added milk) if not within the group are near relatives. Protein milk with 15 or 20 per cent. added sugar (Chart 12) also qualify for membership here, although the name makes these mixtures appear to be entirely unrelated.

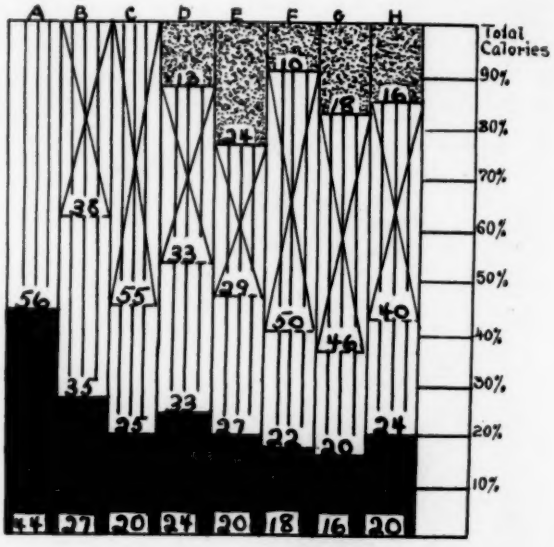

Chart 11.—Effect on the percentage of total calories in protein, carbohydrate and fat in various modifications of skimmed milk. *A*, skimmed milk (protein, 3.5 per cent., carbohydrate 4.5 per cent.), calories = 0.32 per c.c.; *B*, skimmed milk, cane sugar, 5 per cent., calories = 0.52 per c.c.; *C*, skimmed milk, cane sugar, 10 per cent., calories = 0.72 per c.c.; *D*, skimmed milk, cane sugar, 5 per cent., butter 1 per cent. (fat, 0.85 per cent.), calories = 0.6 per c.c.; *E*, skimmed milk, cane sugar, 5 per cent., butter, 2 per cent. (fat, 1.7 per cent.), calories = 0.68 per c.c.; *F*, skimmed milk, cane sugar, 10 per cent., butter, 1 per cent. (fat, 0.85 per cent.), calories = 0.8 per c.c.; *G*, skimmed milk, cane sugar, 10 per cent., butter, 2 per cent. (fat 1.7 per cent.), calories = 0.88 per c.c.; *H*, Holländische Säugingsnahrung (protein, 2.7 per cent.; carbohydrate = 3.5 per cent., fat, 1 per cent.), cane sugar, 5 per cent., wheat flour, 5 per cent., calories = 0.55 per c.c.

SKIMMED COW'S MILK

Group 4.—The percentage representation in the total calories of protein, carbohydrate and fat in members of this group approach those of completely skimmed milk: 45, 55 and 0 per cent., respectively (Chart 11). Completely skimmed milk, either as sweet milk or as lactic acid milk, is the simplest food used in infant feeding in the sense that it contains only two energy yielding food components. Because of this very simplicity, which depends on a deficiency, skimmed milk may be regarded as an abnormal food. Its extreme position, as shown

in Charts 7 and 8, far removed from human milk, and indeed from all natural milks, would corroborate this view. On the other hand, skimmed milk serves as a convenient simple base for building up more adequately balanced foods and many successful feedings may be most easily looked on as modifications of skimmed milk. The "Holländische Säuglingsnahrung" [11]—widely and successfully used—is a sour skimmed milk containing 1 per cent. fat with sugar and flour added. Dryco and half-strength Klim are skimmed milks containing some fat; so also is Mammala but with added carbohydrate also. The success attributed to these dried, partially skimmed milks may be due in part to the fact that the removal of fat from whole milk not only reduces the proportion

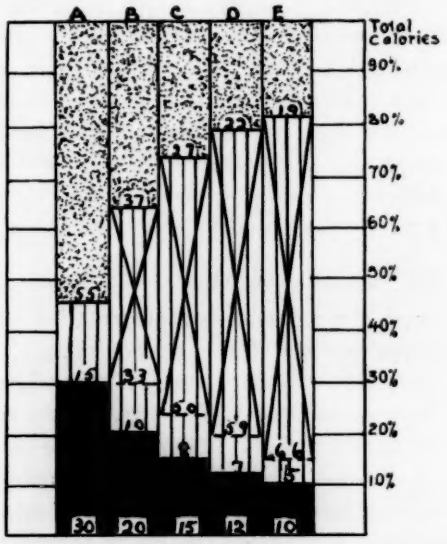

Chart 12.—Various protein milk mixtures expressed in terms of the percentage of total calories in protein, carbohydrate and fat. *A*, protein milk, calories = 0.37 per c.c.; *B*, protein milk, cane sugar, 5 per cent., calories = 0.61 per c.c.; *C*, protein milk, cane sugar, 10 per cent., calories = 0.81 per c.c.; *D*, protein milk, cane sugar, 15 per cent., calories = 1.01 per c.c.; *E*, protein milk, cane sugar, 20 per cent., calories = 1.21 per c.c.

of the total calories in that component, but, at the same time, has the effect of raising the proportions in protein and sugar. Chart 11 illustrates the simplicity and abnormality of skimmed milk and the effect on it of various modifications, most of which fall within the confines of the majority group of mixtures used in infant feeding. These mixtures are fairly high in protein and mixed carbohydrate and relatively low in fat.

11. Finkelstein, H.: Lehrbuch der Säuglingskrankheiten—Zweite Auflage, Berlin, J. Springer, 1921.

PROTEIN MILK

Group 5.—Like skimmed cow's milk, protein milk stands apart as a unique food; 30 per cent. of the total calories are allotted to protein, 15 to carbohydrate, and 55 to fat (Chart 12). The picture is exactly the reverse of the whey group of mixtures with their high sugar and low protein and fat. Even the addition of 5 or 10 per cent. sugar does not completely efface the peculiar makeup of this freak mixture. With the addition of 10 per cent. sugar, protein and fat are still well represented in percentages of the total calories. By name, whether in English or in German, attention is called to the high protein content of protein milk, but it ought to be equally well known that the fat content of this food is high. This fact is shown by its percentage composition, but is strikingly brought out when food components are graphed in terms of percentages of total calories. The percentage of total calories in fat (55) is the highest existing in any mixture used in infant feeding. As breast milk combines high fat with the lowest protein found in any milk mixture, so protein milk combines the highest fat with very high protein. Without the addition of carbohydrate, albumin milk is being less and less frequently used in infant feeding.

SWEETENED CONDENSED MILK

Group 6.—Here the percentage representation in the total calories of protein, carbohydrate and fat is approximately 10, 65 and 25 per cent., respectively; the caloric value of the added carbohydrate is 50 per cent. of the total calories (Chart 13). These mixtures are known in the Pirquet nomenclature as "dubo," because one-half the calories are in milk and one-half are in added carbohydrate. Some of the familiar members of this group may be enumerated in the order of their admitted orthodoxy in infant feeding as follows: one-third strength whole cow's milk with 5 per cent. added sugar, one-half strength whole cow's milk with 8 per cent. added sugar, two-thirds whole cow's milk with 10 per cent. added sugar, full strength cow's milk with 17 per cent. added sugar, and, lastly, sweetened condensed milk itself. These mixtures differ from each other only in concentration, a striking fact probably not generally appreciated and not easily demonstrable in the usual percentage manner of evaluating and comparing foods. These mixtures probably contain the minimum of fat and perhaps less than the minimum of protein which it is safe to give to any child for any considerable period of time.

MAJORITY GROUP

Group 7.—There is a final group which includes practically all other milk mixtures used in the artificial feeding of infants and, since it includes many of the mixtures commonly used in practice, it may be

termed the majority group. The members of this group, although heterogeneous in their ancestry and constitution, cluster around the sweetened condensed milk family just described. The percentage of the total calories in protein varies between 10 and 20 per cent. and in fat between 15 and 30 per cent. Thus, the mixtures which are given to most artificially fed children contain somewhat more than 10 per cent. of the total calories in protein, and at least 15 per cent. of the total calories in fat. These values probably represent fairly satisfactory levels for these food components. In whole milk modifications, these requirements are met if 60 per cent. of the total calories are in milk, and 40 per cent. are in added carbohydrate. The European

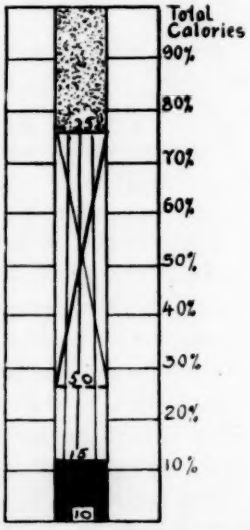

Chart 13.—Milk mixtures which seem widely different but which are identical when expressed in terms of the percentage of total calories in protein, carbohydrate and fat: whole cow's milk, 1 part, water, 2 parts, cane sugar, 5 per cent., calories = 0.42 per c.c.; whole cow's milk, 1 part, water, 1 part, cane sugar, 8 per cent., calories = 0.66 per c.c.; whole cow's milk, 2 parts, water, 1 part, cane sugar, 10 per cent., calories = 0.84 per c.c.; whole cow's milk, cane sugar, 17 per cent., calories = 1.3 per c.c.; sweetened condensed milk, calories = 3.3 per c.c.

rule of giving one tenth of the body weight in whole milk and one one-hundredth of the body weight in sugar as a daily ration is but the expression of a definite feeding allowance of a mixture which is actually whole cow's milk with 10 per cent. added sugar. This formula, when analyzed, shows that 13 per cent. of the total calories are in protein, 30 per cent. in fat, 18 per cent. in lactose and 39 per cent. in added carbohydrate. In other words, 60 per cent. of the total calories are in whole milk and 40 per cent. in added carbohydrate. In skimmed milk

modifications, the protein and fat requirements are probably adequately met, if sugar and fat are added in amounts corresponding to 10 and 2 per cent., respectively, of the volume of the mixtures. Whatever the optimum protein intake of artificially fed infants may be, whether fairly fixed, or shifting with nutritional status, the fact remains that many infants have thriven on skimmed milk whether sweet or sour, reinforced with mixed carbohydrate and sufficient fat to cover fat soluble A requirements. Some milk fat is required because of its intimate association with vitamins and some is useful because of its high energy value. The relationship between fat and mineral metabolism is close. It is not established to what extent fat and carbohydrate are not isodynamically interchangeable in the infant's metabolism, but they are to a considerable degree.

Chart 8 demonstrates the intermediate position of the majority group of milk mixtures as determined on an ascending scale of protein percentages of the total calories. As already pointed out, it is obvious that the feedings in this group are similar to sweetened condensed milk; they differ chiefly in their somewhat higher protein content. The majority group is situated also next to the whey group from which it differs, calorically speaking, chiefly in having a greater percentage of the calories in fat. The majority group is thus intermediate between sweetened condensed milk on the one hand and the wheylike foods on the other. This would seem to be a surprising fact. *A priori,* one would not expect the majority of milk mixtures commonly used in infant feeding to be fashioned after freak mixtures such as skimmed milk or protein milk, but one would expect them to be much like human milk. That such is not the case is brought out in Chart 8. In contrast to human milk, which combines the lowest percentage of total calories in protein with the highest percentage in fat, the majority group mixtures show higher values for the percentages of total calories in protein and carbohydrate and a lower value for that of fat. The only natural milk to whose caloric percentage pattern the members of the majority group conform is that of the ass. It is of interest to point out that some French pediatricians hold ass's milk next in favor to human milk as an infant food.[12] The milk mixtures which conform to the caloric percentage distributions of the majority and sweetened condensed milk groups are widely used, because experience has shown that most infants thrive on one or another of them. If one mixture in the group does not seem satisfactory, then another mixture is tried and perhaps still another and probably, finally, sweetened condensed milk itself. Physicians little realize that these mixtures differ but little from one

12. Czerny, A., and Keller, A.: Des Kindes Ernährung, Ernähungsstörungen und Ernahrungstherapie, Leipzig and Wein, Franz Deuticke, 1923.

another except in the amount of dilution and degree of cooking. It is an astonishing fact that one-third strength cow's milk with 5 per cent. sugar—a mixture universally used in infant feeding and regarded as orthodox by pediatricians of all schools—differs from sweetened condensed milk as it comes from the can only in degree of dilution and extent of denaturization by cooking and storage. On no mixtures in the other groups discussed have large numbers of average infants been fed successfully for considerable lengths of time.

This method of food analysis may be carried out to the most minute detail. For example, not only may the percentage of the total calories in protein be determined and graphed but the protein calories

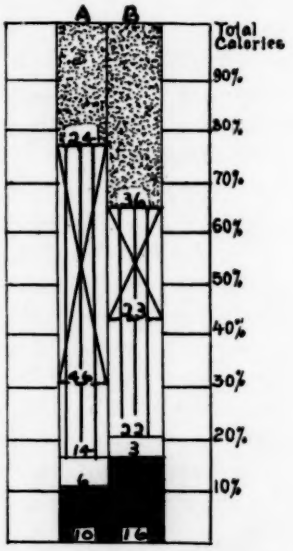

Chart 14.—Two Mellin's Food mixtures expressed in terms of the percentage of total calories in milk protein, vegetable protein, carbohydrate and fat: *A*, whole cow's milk, 1 part, water, 3 parts, Mellin's Food, 5 per cent., calories = 0.33 per c.c.; *B*, whole cow's milk, 3 parts, water, 1 part, Mellin's Food, 5 per cent., calories = 0.65 per c.c.

may be further analyzed. A graphic analysis of two Mellin's Food formulas are shown in Chart 14. The two mixtures graphed contain a rather high percentage of the total calories in protein, due to the fact that Mellin's Food contains vegetable protein. The vegetable protein is easily shown distinct from the milk protein. In the future, vegetable protein may be shown to give the carbohydrate mixtures containing it a distinct nutritive value. Malt-soup and butter-flour preparations are other noteworthy mixtures containing vegetable protein. In a similar manner, all forms of added protein, carbohydrate and fat may be estimated and charted and the importance of the individual constituents to infant nutrition may be determined.

One outstanding revelation of this method of approach to the problems of infant feeding has been that large numbers of supposedly different foods are similar, even identical, in all respects save their water content. The question of the relation of water to the digestibility of foods is thus brought to the forefront. Without doubt, there is an undetermined minimum of water required for digestion. There are, however, no exact data to indicate to what extent dilution is a benefit. There is no doubt that dilution is often an evil. Frequently infants fed on extremely dilute mixtures have become dystrophic either because the bulk of the food required to give the child sufficient energy for growth has been greater than it could take, or else the required amount has been taken and as promptly vomited from mechanical causes. The end-result is the same in either case. The influence of water on the digestibility of food needs further study, but primarily the infant's requirement of water must be considered rather than his food's requirement to increase its digestibility. Furthermore, no fixed standard for the comparison of various foods can be set up so long as the water content (that is, total volume) is used as the basis.

Our knowledge of vitamins at present does not permit an experssion of their quantitative values. Cow's milk, the basis of practically all infant foods, contains several vitamins, the potency and quantity of which are probably determined to a considerable degree by the dietary and seasonal changes to which cows are subjected. Mixtures very low in milk content or deficient in certain components of milk may be incomplete foods in this sense and probably require reinforcement by the independent administration of vitamins. In the hope of making the protein or fat of milk more digestible by dilution with water, pediatricians have lost sight of the serious consequences which may result from reducing thereby the vitamin content of the food, for it is the custom to enhance the nutritional value of the diluted milk only by the addition of and, therefore, further dilution with a nonvitamin fuel component, that is, sugar. The following quotation from Osborne and Mendel[13] is of interest in this connection:

> From a practical standpoint a more precise understanding of the quantitative relations of the vitamins is highly desirable. The fact that such diverse cellular structures as yeast, wheat embryo, corn germs, and glandular tissues show a surprising richness in growth-promoting properties aside from their protein and mineral content, is of immediate significance at a time when milk is still so uniquely valued for its nutrient virtues. . . . A particular case of this kind is that of an infant feeding where it is customary to reinforce the supply of calories by diluting top milk and adding milk sugar. Under these circumstances the child is supplied with a food that contains a relatively smaller proportion of the water-soluble vitamin than does the original cow's milk. While milk

13. Osborne, T. B., and Mendel, L. B.: Milk as a Source of Water-Soluble Vitamin, J. Biol. Chem. **34**:3, 1918, 543.

thus modified may contain sufficient vitamin as long as the food intake is normal, if for any reason the child's appetite fails the vitamin supply is reduced and endless dietary troubles may easily result. . . . This is a practical question which deserves prompt investigation, for the best way to reinforce the vitamin content of the diluted milk is not yet evident, chiefly owing to our still limited knowledge of the distribution of this vitamin in nature. Such investigations as have been made demonstrate that the proportion of water-soluble vitamin in the various vegetable and animal tissues differs greatly, and it is probable that sooner or later some way will be found to a solution of the problem of successful infant feeding.

In regard to the salt content of infant feeding mixtures, it may be stated that in general the mineral constituents of most of them parallels the milk content. When milk is diluted with water and the requisite calories of a milk mixture made up with salt-poor food components, the actual mineral intake is greatly reduced. The salt content of milk mixtures may be so expressed to bring out its relationship to the total energy value of the food or to that of any one of the food components. For example, in human milk there are 2.7 mg. of inorganic salts for every calory of milk, and 33 mg. for every calory of protein.[14] In comparing the mineral content of various foods as Shohl [15] has pointed out, the salts may "be calculated in common terms, namely, as normal solutions. The analogy to energy metabolism is obvious. Salts can be evaluated in cubic centimeters of normal solution just as grams of protein, carbohydrate and fat can be reckoned in calories. The calcium requirement can be expressed in cubic centimeters of normal solution or percentage of the total cubic centimeters of salt, just as the protein requirement can be stated in calories or in percentage of the total calories. Given the total requirement, the extent to which salts are interchangeable must be determined for the various radicals, just as isodynamic quantities of fat and carbohydrate can be calculated. Amounts of minerals can be compared directly as chemical equivalents."

Not only do infant feedings of identical or similar caloric percentage pattern differ in their water, vitamin and mineral content but also they may be very unlike in the chemical and biologic values of all the various food components. In grouping milk mixtures on the basis of similar caloric constitution for the food components, this vital aspect of the nutritional problem is neither ignored nor relegated to the background; on the contrary, it is brought into prominence. Indeed, milk mixtures shorn of their water relationships and reduced to caloric expression, present themselves for study, not alone from the point of view of energy values but also from that of the biochemical values of the

14. Computation on the basis that 100 c.c. of human milk contains 200 mg. of inorganic salts and has an energy value of 73 calories of which 6 are supplied by protein.

15. Shohl, A. T.: Mineral Metabolism in Relation to Acid-Base Equilibrium, Physiol. Rev. **3**:509 (Oct.) 1923.

various components. The wide range of opinion among clinicians as to the effect both in health and disease of this or that form of protein, carbohydrate or fat, is eloquent testimony to the fact that few data are actually established which correlate qualitative differences in food components with physiologic response. The energy unit is thus perhaps not the ultimate basis for a helpful classification and accurate study of infant feedings but just now its use would seem to be a step toward that simplicity which must prevail, if progress is to be rapid in the correlation of food with nutritional status and disturbance. Cathcart [14] says:

> No one will, of course, seriously maintain that nutrition can ultimately be reduced merely to the satisfying of the energy demands; the calory factor may be regarded as strictly secondary to the supply of material. We do not live on calories, yet all our general estimates of food requirements are quite properly for the most part made in terms of calories. Calory value is simply a very convenient physical standard for the assessment of diets, but merely because such a standard has proved of great utilitarian value there is no real justification for placing this standard as the foundation stone of hypotheses framed to offer an explanation of cellular activity.

SUMMARY

The constitution of a great number of the milk mixtures commonly used in infant feeding has been expressed in terms of the percentage of each energy-producing nutrient in the total energy value of the food as fed. This method of food evaluation has been the means of extricating these heterogeneous mixtures from a maze of quantitative relationships which are metabolically meaningless, and has made them available for comparative study on a significant basis in terms of the standard unit of nutritional currency—the calory—and without regard to water content. In this simple way, a host of apparently dissimilar milk mixtures have lost an artificial individuality and have been classified in seven distinctive groups. Here individual differences may be studied where they actually exist, that is, in mineral content, chemical and biologic values of protein, carbohydrate and fat, degree of denaturization and water content.

CONCLUSIONS

The following points may be emphasized in concluding this study:

1. The dilution of milk mixtures with water affects the calories per unit of mass, but not the percentage relationships of protein, carbohydrate and fat in the total calories.

2. The addition to milk mixtures of an energy yielding nutrient affects not only the total calories per unit of mass, but also diminishes the proportional representation in the total calories of the protein, lactose and fat.

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14. Cathcart, E. P.: The Influence of Fat and Carbohydrate on the Nitrogen Distribution in the Urine, Biochem J. **16**:747, 1922.

3. The magnitude of any food component in a mixture, as expressed by its percentage representation in the total calories, is relatively increased by the removal or reduction of any other food component.

4. An energy-yielding nutrient, if introduced in a ratio fixed with relation to the other energy-yielding components of mixtures made increasingly dilute with water, does not affect the representation in the total calories of the other components.

5. On the other hand, an energy-yielding nutrient, if introduced in a ratio fixed with relation to the total constant volume of mixtures made increasingly dilute with water, brings about a reduction in the values of the protein, lactose and fat percentages of the total calories.

6. When the multitude of milk mixtures commonly used in infant feeding are reduced to the caloric percentage formulation, it is perceived that many of them are essentially alike or identical excepting in concentration, degree of denaturization by cooking or souring and qualitative differences in protein, carbohydrate, fat and salts.

7. Practically all milk mixtures may be found in one of seven groups.

8. A great number of mixtures which experience has shown to be particularly successful in feeding infants fall into a majority group which approaches the caloric percentage pattern of the food mixtures in the sweetened condensed milk group; about 60 per cent. of the total calories are in whole milk and 40 per cent. in added carbohydrate.

9. One-third milk with 5 per cent. added sugar, and other somewhat less frequently used mixtures, have the identical caloric percentage configuration of sweetened condensed milk and of whole milk to which 17 per cent. sugar has been added.

10. Human milk, cow's milk, whey, protein milk and skimmed milk are the most prominent representatives of the remaining five groups.

11. The Czerny-Kleinschmidt and Moro butter-flour mixtures have the same proportions of the total calories in protein, carbohydrate and fat as has human milk.

12. It is a striking fact that the vast majority of successful milk mixtures used in infant feeding are unlike human milk, which stands apart from all other foods; indeed the popular mixtures are as unlike human milk as they are unlike unmodified cow's milk.

KETOSIS ACCOMPANYING INFECTIONS IN CHILDREN *

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It is a matter of common knowledge that ketosis is of frequent occurrence in children, and that it accompanies a variety of clinical conditions, including some of minor nature. It has been especially noted that certain infections of the respiratory tract lead to ketonuria. Frew,[1] using the delicate nitroprussid reaction on the urines of a large number of unselected hospital patients, found the reaction positive in a considerable proportion. He considered the ketosis due to metabolic factors which were independent of any particular disease per se. Roberts [2] noted a high incidence of ketosis in children suffering from respiratory infections, although he also found ketosis to be present in a wide variety of conditions.

The nitroprussid reaction on the urine is so extremely delicate that a positive test does not necessarily indicate ketosis of a significant degree. The ferricchlorid test is less delicate, and when positive is of greater significance (Bigwood and Ladd [3]).

The present study deals with a group of children suffering from acute infections associated with a ketosis sufficiently marked to give a positive ferricchlorid reaction in the urine.

CAUSE

The ketosis accompanying infections may conceivably be due to one or more of the following factors:

1. Insufficient food intake, as a result of anorexia or vomiting.

2. An increased metabolism associated with fever, which may result in depletion of the carbohydrate reserves of the body.

3. A disturbance of the intermediary metabolism of carbohydrate due to the effects of the infection itself.

In order to gain some idea as to which of these factors were operative, a study of the blood sugar curve following the ingestion of carbohydrate was made. If the ketosis were due to a low food intake, or to an increased rate of metabolism associated with fever, one would expect a normal sugar curve, as storage should occur with the ordinary rapidity.

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* From the Department of Pediatrics, Washington University School of Medicine, and the St. Louis Children's Hospital.

1. Frew, R. S.: Lancet **2**:1264 (Nov.) 1911.
2. Roberts, O. W.: Lancet **1**:118-120 (Jan. 19) 1924.
3. Bigwood, E. J., and Ladd, W. S.: J. Biol. Chem. **58**:347 (Nov.) 1923.

If, on the other hand, carbohydrate metabolism were at fault, the curve should be abnormal and of the "diabetic" or "lag" type. It is to be noted in this connection that Severinghaus [4] has shown that a blood sugar curve of the type seen in mild diabetes and associated with ketosis occurs in normal persons who have been fasting for as long as two days. None of our patients, however, had been subjected to anything like this degree of starvation.

It was thought probable that if a disturbance of carbohydrate metabolism were present, this disturbance would likely be in the nature of an interference with the glycogenic function of the liver. It was, therefore, considered desirable to use a test which would serve to indicate the functional capacity of the liver as related to carbohydrate metabo-

TABLE 1.—*Results of Tests in Children Not Suffering from Ketosis*

Case	Description	Time	Per Cent. Blood Sugar
1	J. M., boy, aged 8 years; weight, 27 kg. Convalescent from pneumonia	10:30	0.102
		10:35	Levulose 20 gm.
		11:05	0.113
		11:25	0.116
		12:05	0.122
		12:35	0.104+
2	V. F., boy, aged 6 years; weight, 20.2 kg. Bronchiectasis	10:30	0.109
		10:35	Levulose 20 gm.
		11:05	0.115
		11:35	0.109
		12:05	0.087
		12:35	0.104
3	J. F., boy, aged 5 years; weight, 15.9 kg. Convalescent from scarlet fever	10:35	0.104
		10:40	Levulose 20 gm.
		11:10	0.117
		11:40	0.117
		12:15	0.104
		12:40	0.104
4	R. M., boy, aged 4 years; weight, 18 kg. Cardiac disease	10:35	0.113
		10:40	Levulose 20 gm.
		11:10	0.109
		11:40	0.109
		12:10	0.111
		12:40	0.115

* The urines of all these showed an absence of ketone bodies.

lism. The levulose test is particularly appropriate for this purpose. It has been shown by Bergmark,[5] Isaac,[6] MacLean and de Wesselow,[7] and Spence and Brett [8] that the blood sugar curve following the administration of levulose is quite different from that following the administration of glucose (MacLean and de Wesselow,[7] Hamman and Hirschman [9]). When a normal subject is given a "loading" dose of levulose.

4. Severinghaus, E. L.: J. Biol. Chem. **63**:xlviii (Feb.) 1925.
5. Bergmark: Jahrb. f. Kinderh. **80**:373-385, 1914.
6. Isaac, S.: Med. Klin. **16**:1207-1210 (Nov. 21) 1920.
7. MacLean, H., and de Wesselow, O. L. V.: Quart. J. Med. **14**:103 (Jan.) 1921.
8. Spence, J. C., and Brett, P. C.: Lancet **2**:1362 (Dec.) 1921.
9. Hamman, L., and Hirschman, J. J.: Studies on Blood Sugar, Arch. Int. Med. **20**:761-888 (Nov.) 1917.

TABLE 2.—*Findings in a Group of Children Suffering from Ketosis*

Case	Description	Time	Per Cent. Blood Sugar	Urine: FeCl3 Before	Urine: FeCl3 After	Urine: Rothera Before	Urine: Rothera After
1	R. S., a boy, aged 2½ years; weight, 9.5 kg. Tuberculous meningitis	12:15	0.149	±	—	+++	Trace
		12:20	Levulose 20 gm.				
		12:55	0.159				
		1:30	0.175				
		2:0	0.154				
		2:35	0.141				
2	A. D., a girl, aged 6 years; weight, 24.5 kg. Pneumonia	11:40	0.178	++	Lost	++++	Lost
		11:45	Levulose 20 gm.				
		12:15	0.189				
		12:45	0.189				
		1:15	0.178				
		1:45	0.172				
3	B. L. M., a boy, aged 7 years; weight, 19.5 kg. Pneumonia	10:55	0.128	+	—	+++	+
		11:0	Levulose 20 gm.				
		11:30	0.131				
		12:0	0.135				
		1:0	0.144				
		2:0	0.144				
4	M. O., a girl, age 7 years; weight, 12 kg. Pneumonia (had been having little food as appetite was poor)	11:0	0.149	+++	+	++++	++
		11:05	Levulose 20 gm.				
		11:35	0.140				
		12:05	0.152				
		12:35	0.180				
			0.220				
5	C. C., a boy, aged 7 years; weight, 24.7 kg. Pneumonia	10:35	0.128	+	±	—	+
		10:40	Levulose 20 gm.				
		11:10	0.158				
		11:40	0.160				
		12:10	0.150				
		12:40	0.152				
6	M. S., a boy, aged 3 years 3 months; weight unknown Streptococcal sore throat. Bronchitis	11:0	0.109	±	—	+++	++
		11:05	Levulose 20 gm.				
		11:35	0.181				
		12:05	0.115				
		12:35	0.113				
		1:05	0.113				
7	W. D., a boy, aged 5 years; weight, 15.5 kg. Pharyngitis. (Constipated and vomiting for 5 days)	9:55	0.111	+	—	++	—
		10:0	Levulose 20 gm.				
		10:30	0.149				
		11:0 *	0.156				
		11:45	0.114				
		12:15	0.128				
8	E. M., a girl, aged 3 years; weight, 10 kg. Pneumonia	10:40	0.097	—	—	Trace	Trace
		10:45	Levulose 20 gm.				
		11:15	0.109				
		11:45	0.110				
		12:15	0.123				
		12:45	0.132				
9	C. M., a boy, aged 4 years; weight, 18.2 kg. Foreign body in nose. Bronchitis	10:35	0.104	+	—	++	—
		10:40	Levulose 20 gm.				
		11:10	0.133				
		11:40	0.128				
		12:10	0.135+				
		12:40	0.111				
10	M. J., a boy, aged 5 years; weight, 15.4 kg. Pneumonia	10.30	0.102	+	±	+++	+
		10:40	Levulose 20 gm.				
		11:10	0.111				
		11:40	0.125				
		12:10	0.129				
		12:40	0.117+				
11	P. G., a girl, aged 4 years; weight, 15.2 kg. Pneumonia	10:55	0.094	+++	+++	++++	++++
		11:0	Levulose 20 gm.				
		11:30	0.115				
		12:0 †	0.122				
		12:30	0.125				
		1:0	0.100				
12	J. G., a boy, aged 10 years; weight, 30.5 kg. Pleurisy	10:40	0.104	+	±	++	++
		10:45	Levulose 20 gm.				
		11:15	0.102				
		11:45	0.115				
		12:15	0.109				
		12:45	0.106				

* Child vomited a good deal.
† Child vomited.

the blood sugar remains low and the "curve" is practically flat. If, however, hepatic insufficiency is present, the curve rises and the sugar content of the blood remains above normal for more than two hours. Bodansky,[10] working with dogs, recently confirmed these observations.

METHODS

The patients studied were given a light breakfast, and three hours later the test was begun. This three hour fast was instituted in order to insure a normal fasting level of the blood sugar. Urine specimens were collected before and after each experiment and tested for acetone bodies by both the nitroprussid and the ferricchlorid reactions. The amount of levulose determined on was dissolved in about 75 c.c. of water and given by mouth immediately after taking a sample of fasting blood. Blood samples were then taken at half hourly intervals for the next two hours.

TABLE 3.—*Findings in Children Suffering from Hepatic Insufficiency*

Case	Description	Time	Per Cent. Blood Sugar
1	L. T., a boy, aged 4 years; weight, 25.2 kg. Syphilis of the central nervous system. Jaundice and fever subsequent to tryparsamide	2:30	0.122
		2:35	Levulose 20 gm.
		3:05	0.122
		3:35	0.156
		4:05	0.126
		4:35	0.131
2	L. E., a boy, aged 5 years; weight, 9.9 kg. Anemia; greatly enlarged liver; enlarged spleen (?); slight ascites; no jaundice	10:35	0.080
		10:40	Levulose 20 gm.
		11:10	0.160
		11:45	0.170
		12:15	0.100
		12:45	0.117

Blood was obtained by pricking the finger or toe, and the blood sugar estimations were carried out by MacLean's [11] micromethod.

The dose of levulose used was 20 gm. for each child. This did not in any instance exceed 3 gm. per kilogram of body weight. Spence and Brett [8] recommended dosage according to weight, but Bergmark [5] found that a dosage of levulose varying from 9 to 50 gm. did not alter the type of curves in children. Jörgensen and Plum [12] also found that it was not necessary to vary the dose according to weight, even when the sugar was given intravenously.

A group of several normal children of varying ages and weights was selected as controls. The results of these tests appear in Table 1. These results are quite in keeping with those of previous workers.

In Table 2 are given the findings in a group of children suffering from ketosis associated with infections.

10. Bodansky, M.: J. Biol. Chem. **58**:514-522 (Dec.) 1923.
11. MacLean, H.: Biochem. J. **13**:135-147 (July) 1919.
12. Jörgensen, S., and Plum, T.: Acta. Med. Scandinav. **58**:161-200, 1923

In Table 3 are given the findings in a group of children suffering from hepatic insufficiency for comparison with the foregoing cases.

As has been stated in a previous paper,[13] a rise of blood sugar of 30 mg. above the fasting level, or a blood sugar curve reaching a peak of 0.135 mg. or over, may be considered as indicative of hepatic insufficiency. A lag in the return to normal, with a blood sugar value higher than the fasting level at the end of two hours, is also very strong evidence of this. The curve obtained after the administration of chemically pure levulose is flatter than when commercial levulose is used. This difference is to be attributed to the absence of glucose in the

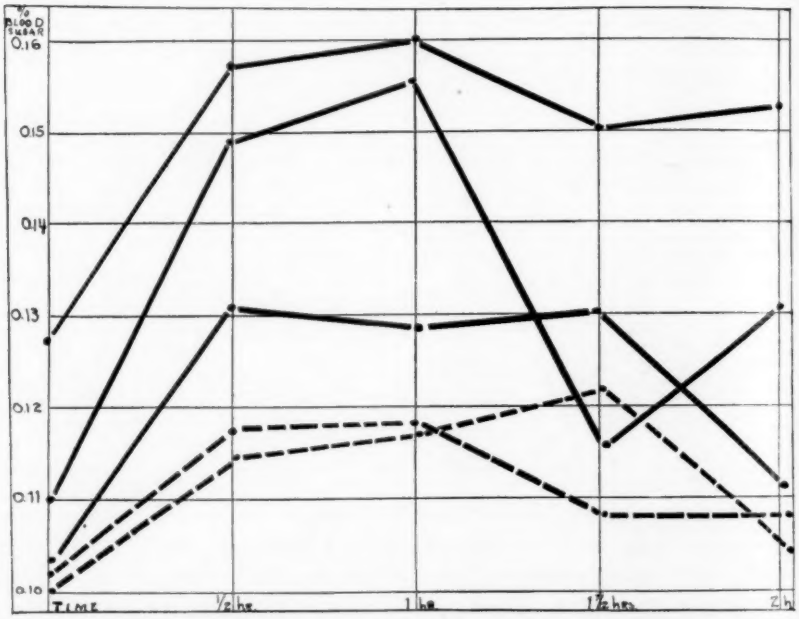

Chart 1.—Straight lines, ketosis curves; broken lines, normal.

purified material. The sugar used in these tests was the chemically pure levulose of Pfanstiehl. In using this pure sugar, a rise of 25 mg. above the fasting level, or a peak of 0.125 per cent. of sugar in the blood, may be considered as highly suggestive of hepatic insufficiency.

The cases fall into three main groups. Two cases (10 and 11) showed a normal fasting blood sugar. This value rose to from 27 to 31 mg., the peaks being at 0.129 and 0.125 mg., respectively. In Case 10 the blood sugar did not return to the normal fasting level within two hours. In Case 11 some vomiting occurred before the experiment was ended and this may have been the cause of the low terminal values. It

13. Tallerman, K. H.: Quart. J. Med. **17**:37-52 (Oct.) 1923.

is to be noted that vomiting a portion of the loading dose of sugar tends to prevent the appearance of an abnormal rise in the blood sugar. The sugar curves in these two cases may be considered sufficiently different from the normal controls to arouse the suspicion of hepatic insufficiency.

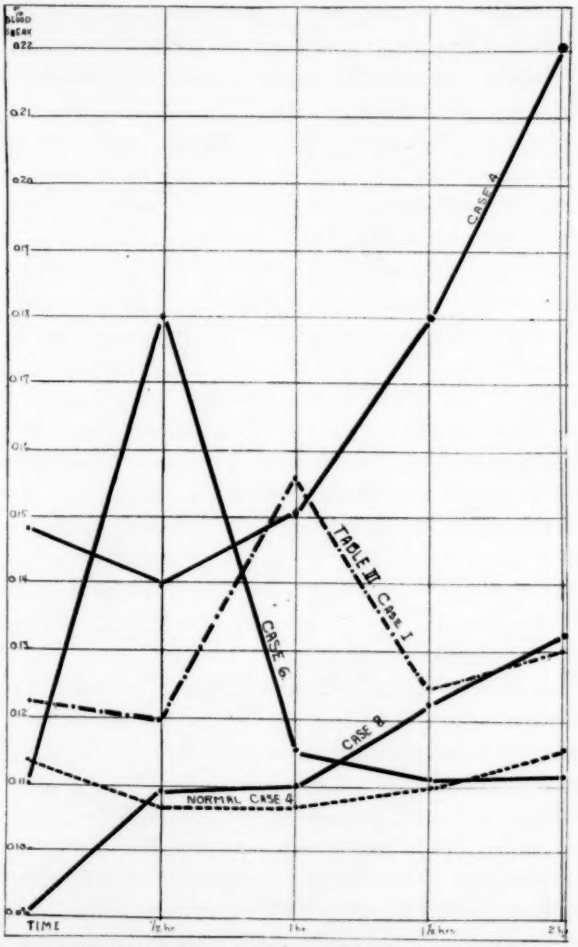

Chart 2.—Straight lines, ketosis cases; dash line, case from Table 3; dot and dash line, normal.

The second group of cases (1, 2, 3, 4 and 5) showed fasting blood sugar values which were definitely above the normal and these values remained high throughout. In Cases 4 and 5, the rise above the fasting level exceeded 30 mg. In the others, although above normal, the increase above the fasting level was not so marked. In Cases 3 and 4, two hours after the administration of the sugar the curve was still high and rising.

In the third group (Cases 6, 7, 8 and 9) the fasting level of the blood sugar was normal, but the increase in each instance was over 30 mg. High peaks were observed in Cases 6 and 7, despite the fact that in Case 7 there was some vomiting.

In Case 8 marked ketosis was present on the evening preceding the test. Only traces of acetone bodies were detected in the urine at the end of the test. The peak of the curve, however, was 36 mg. above the fasting level, and at the end of two hours there was no tendency for the curve to fall.

In only one case studied was the blood sugar curve completely normal (Case 12).

The initial high blood sugar values in several of the cases speak against rather than for an inanition as a cause of the results obtained. It is possible that the response to infection is due to an overaction of the sympathetic nervous system as mentioned by Vines.[14] He pointed out that fever, tachycardia, sweating and hyperglycemia may be considered as evidences of sympathetic overaction. It is possible that the initial high blood sugar values might be explained on the same basis. The levulose test shows, however, a marked liver insufficiency in Cases 4, 5, 6, 7 and 8, and probably insufficiency in Cases 1, 10 and 11. Case 12 alone presents an entirely normal curve.

Figures 1 and 2 illustrate the curves in graphic form.

SUMMARY AND CONCLUSIONS

A study was carried out on a series of children presenting ketosis associated with infection.

A derangement of carbohydrate metabolism, as evidenced by abnormal blood sugar curves has been noted. In the majority of the cases, this appeared to be associated with hepatic inadequacy, as shown by the levulose tolerance test.

It is probable that hepatic function is temporarily deranged as a result of the toxemia of certain infections, and ketosis results from a failure to utilize carbohydrates. Another possibility is that the abnormal blood sugar curves, especially the initial high values, are due in part to overaction of the sympathetic nervous system associated with fever.

A low food intake must be mentioned as a probable contributory factor.

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14. Vines, H. W. C.: Brit. M. J. **2**:854-856 (Nov. 10) 1923.

SKIN TEMPERATURES IN NORMAL CHILDREN *

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During studies on the metabolism of children in the Children's Medical Laboratory of the Massachusetts General Hospital, it became clear that whereas basal metabolism measured heat production, no data were being obtained concerning heat elimination. Since this can only be measured by direct calorimetry, which is not practicable at the present time, other methods of obtaining an indication of the factors which influenced heat loss were sought. It was, therefore, decided to make a series of measurements of skin temperatures of normal and pathologic subjects to determine the reaction of the skin under different conditions. This paper presents some of the findings in the normal series.

Although the thermo-electric needle was used in 1835 by Becquerel and Breschet,[1] there are very few satisfactory measurements of surface temperatures by this means since that time, with the exception of Benedict's work on adults, the first report of which appeared in 1919,[2] and the work of McClure and Sauer,[3] who used essentially the same method in their study of the effect of clothing on the temperature of the skin of infants.

The method used in this investigation was perfected by Prof. Francis G. Benedict, to whom we are indebted for assistance and advice. Observations were made by applying a specially devised thermo-electric couple to the skin and reading the deviation of a galvanometer. The copper constantan thermo-electric element used is constructed as follows: the "hot junction" is made by twisting the wires (0.508 mm. in diameter) together and soldering them; in the "application junction" the wires are touched end to end and soldered in a U-form. A thermos bottle, in which a tenth degree thermometer is suspended, serves as a

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* From the Children's Medical Department, Massachusetts General Hospital, and the Department of Pediatrics, Harvard Medical School.
* This paper is No. 55 of a series of studies in metabolism from the Harvard Medical School and allied hospitals. The expenses of this investigation have been defrayed in part by a grant from the Proctor Fund of the Harvard Medical School for the study of chronic diseases.

1. Becquerel and Breschet: Archives du Museum **1**:383, 1835.
2. Benedict, Miles and Johnson: Proc. Nat. Acad. Sc. **5**:218, 1919.
3. McClure, W. B., and Sauer, L. W.: The Influence of Clothing on the Surface Temperature of Infants, Am. J. Dis. Child. **10**:425 (Dec.) 1915.

constant temperature bath for the hot junction. The constantan wire is about 2 meters long and ends in the application junction, mounted in a hard rubber block as shown in Figure 1.

Readings are made on a portable galvanometer, giving a deflection directly proportional to the difference in temperature between the "hot junction" and the "application junction," with an accuracy of 0.1 C. The portable galvanometer is especially practical in the study of pathologic patients who cannot be moved from the ward. The apparatus should be calibrated with each set of tests made. The apparatus is shown in Figure 2.

In order that the applicator will be close to the temperature of the subject tested, it is placed on the hand or cheek of the observer prior to making a temperature reading. If observations are to be made under clothing, the various spots of the body to be tested are marked with a skin pencil one or two hours before readings are taken and a small piece of adhesive tape pasted just to the left of each spot in order to insure uniformity of results by accurately locating them. This is necessary in order to do away with exposure to room air and the consequent effect on the skin temperature. Benedict found that if a subject was lying in bed well covered, in an environmental temperature of 20 C., and the clothes were suddenly removed, that there was an immediate great loss of heat as measured by direct calorimetry.[4]

The key numbers shown in Figure 3 indicate the positions on the body on which the surface temperature was taken. The numbers used are arbitrary and are not the same as those used by the Nutrition Laboratory in their studies.

The group of five normal children studied varied in ages from 8 to 12 years, and included two males and three females. They were brought to the hospital, placed in bed and covered with a blanket for two hours with only the hands and face exposed. This afforded the most perfect condition possible for heat insulation, since clothes retard the loss of heat from the skin chiefly by maintaining a zone of still air in contact with it. It was impossible to study all the patients in the same room temperature, due to physical difficulties in the room used; the temperature of the room varying from 21 to 24 C. on different days, but never changing more than 0.2 C. during an observation. In all instances it was possible to eliminate the effect of wind velocity. The results of the skin temperature readings taken under the clothes are shown in Figure 4.

The curve in Figure 4 shows the variance in skin temperature of different parts of the body. In general, the skin temperature of the

4. Benedict, F. G.: Lecture given at Mayo Clinic, to be published.

trunk was found to be higher than other parts of the body, with a tendency for the extremities and the exposed parts of the body to be cooler. The temperature of the upper sternum was slightly cooler than that of the rest of the trunk, presumably because it was nearer the edge

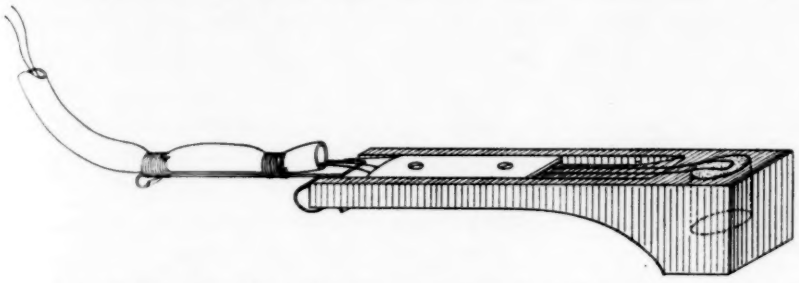

Fig. 1.—Schematic outline of cooper-constantan thermal junction with cotton batting protector and hard rubber support (Benedict, F. G.: Ergebnisse der Physiologie, Festschrift Leon Asher, 1925; in press).

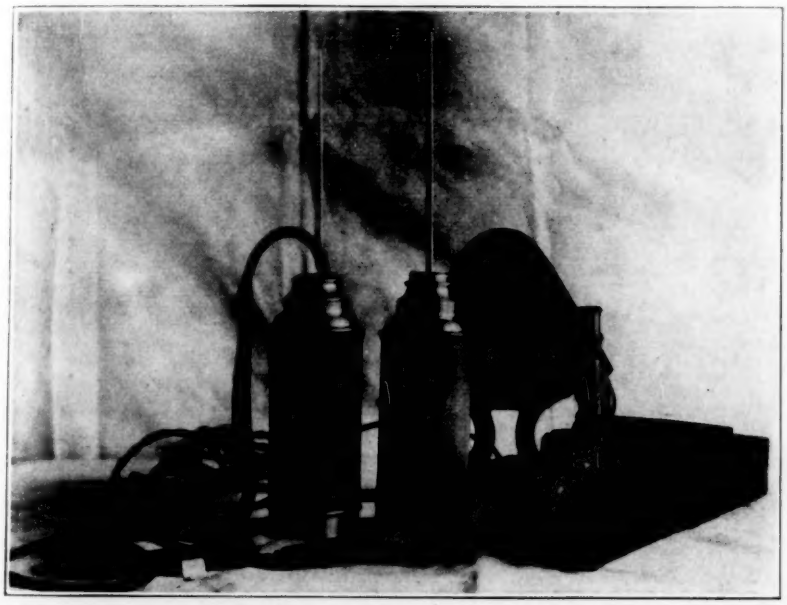

Fig. 2.—The thermos bottle to the left contains the hot junction and the applicator rests on the table. The galvanometer on the right is ready for use.

of the blanket and closer to the outside air. This curve is essentially the same as that recorded for corresponding studies on the adult.[2]

A sixth subject, M. K., a ward patient, ten days convalescent from a digestive disturbance, was studied to determine whether there were any variations in skin temperatures of the same location. With this in

view, temperatures were taken under the bed clothes at intervals of four to ten minutes. She had been up and walking around the ward dressed in nightgown, rompers and cotton dress before she came to the laboratory for study. Here she lay down for about twenty-seven minutes and was covered with a double layer of blankets, after which the series of temperatures were taken. The results may be seen in Table 1.

It was found that, although there were slight local variations in the skin temperatures, the average, especially of the abdomen, tended to relative constancy. The variations were so slight as to make no change

TABLE 1.—*Case M. K., Showing Variations of Skin Temperature of Same Location*

Position	10:52 to 10:56 a. m.	10:56 to 11:00 a. m.	11:00 to 11:03 a. m.	11:13 to 11:17 a. m.	11:17 to 11:21 a. m.
1	33.7 C.	34.1 C.	33.8 C.	34.4 C.	34.8 C.
2	30.3 C.	31.2 C.	30.5 C.	31.0 C.	30.9 C.
3	31.0 C.	31.8 C.	30.9 C.	30.9 C.	32.1 C.
6	34.8 C.	34.6 C.	35.5 C.	35.4 C.	35.8 C.
7	35.3 C.	35.0 C.	35.3 C.	35.3 C.	35.8 C.
8	34.8 C.	34.6 C.	34.7 C.	33.6 C.	34.6 C.
9	35.8 C.	35.5 C.	35.8 C.	35.3 C.	35.4 C.
10	35.8 C.	35.3 C.	35.8 C.	35.5 C.	35.3 C.
11	35.3 C.	35.0 C.	35.3 C.	35.6 C.	35.7 C.
12	34.8 C.	34.7 C.	34.8 C.	35.1 C.	35.0 C.
13	34.8 C.	34.7 C.	35.0 C.	35.1 C.	35.1 C.
14	34.7 C.	33.8 C.	34.1 C.	34.3 C.	34.6 C.
15	34.3 C.	34.2 C.	34.2 C.	34.7 C.	34.8 C.
16	33.8 C.	33.9 C.	34.1 C.	33.6 C.	34.6 C.
17	33.8 C.	33.6 C.	34.0 C.	34.6 C.	34.7 C.
Average	34.2 C.	34.1 C.	34.2 C.	34.2 C.	34.6 C.

TABLE 2.—*Showing Effect of Exposure to a Room Temperature of 22.9 C. on the Skin Temperatures of Y. M., Normal Girl, Aged 12 Years*

Position	1	2	3	6	7	8	9	10	11	12	13	14	15	16	17
Covered	34.4	30.7	31.6	33.9	35.5	35.2	35.6	34.8	35.7	34.5	34.4	33.0	31.2	34.1	34.5
One-half minute after exposure	33.8	31.3	31.7	34.1	34.7	34.7	34.5	34.4	33.8	33.1	33.0	31.6	29.7	32.9	33.0
Seven minutes after exposure	34.0	30.8	31.3	33.2	33.8	33.7	33.5	33.4	32.2	32.2	31.9	30.7	29.4	31.8	32.6
Eighteen minutes after exposure	33.5	30.0	31.0	32.8	32.6	33.0	33.2	33.0	31.4	31.8	31.5	31.4	29.4	32.5	32.8
Twenty-eight minutes after exposure	33.8	30.2	31.1	32.7	32.7	33.1	32.9	32.9	31.5	31.2	31.5	29.7	28.4	32.7	32.6

Average room temperature is 22.9 C.

in the general picture, and show that one set of readings is sufficient to give the general trend of the temperature of the skin of the various parts of the body.

EFFECT OF EXPOSURE TO ROOM TEMPERATURE ON THE TEMPERATURE OF THE SKIN

Since the reaction of the temperature of the skin of children exposed to room temperature has not been studied, a series of observations were made on this normal group by exposing them without clothes to ordinary room temperature.

Skin temperatures were first taken under the clothes, the clothes were then removed and the temperatures were taken at intervals for about thirty minutes. The temperature of the room was 21 C. on some days and not higher than 24.4 C. on others. Table 2 shows the skin temperature readings taken exposed and unexposed on Case Y. M. The averages of some of the readings appear again in Table 3.

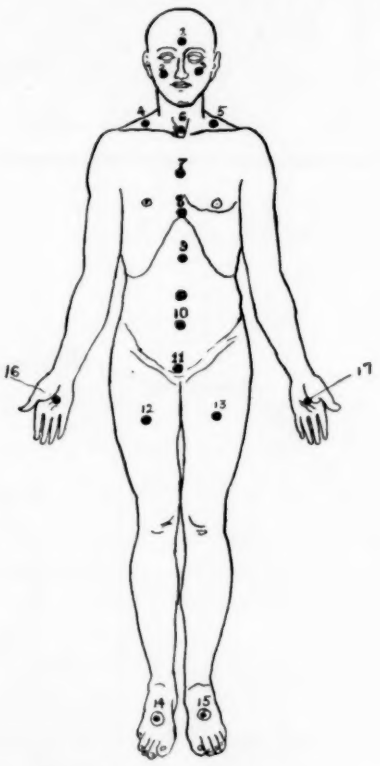

Fig. 3.—The key numbers indicate the positions on the body on which the surface temperature was taken. Numbers 14 and 15 indicate the soles of the feet; numbers 16 and 17 indicate the backs of the hands.

Table 2 shows changes in the skin temperature of different parts of the body of Case Y. M. when exposed to room temperature. The greatest fall in the skin temperature took place within seven minutes after exposure. The temperature of different locations on exposure did not change the same in all instances. There was usually a slightly greater fall in the temperature of the lower extremities than elsewhere, but in no instance was the total fall more than 4.2 C.

An increase in skin temperatures was found when the temperature readings taken on exposure were compared with the readings previously

made under clothing. This increase was found, however, more often on the exposed parts, that is, the face and head. The same phenomenon was seen in other cases, and the question arose as to whether the thermocouple was insufficiently warmed by the preliminary warming on the hand. The fact that the head temperatures were the first of the series

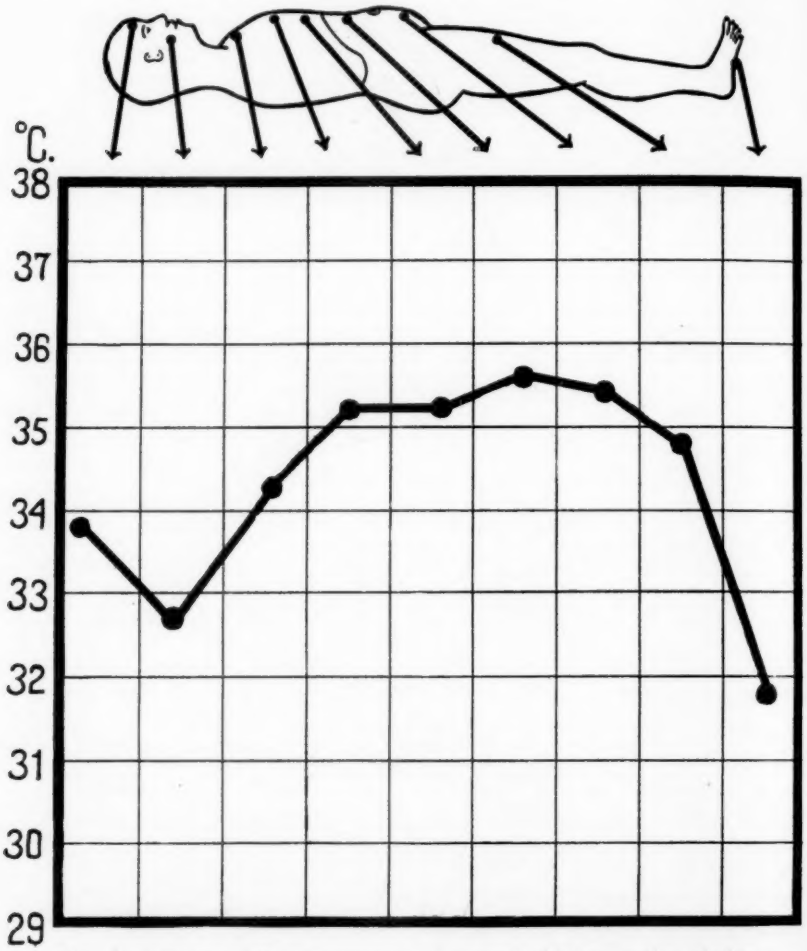

Fig. 4.—Average skin temperature of normal children under clothes.

to be taken made this a possibility. With this in view, a series of temperatures were taken in which the order was changed, so that the trunk temperatures were taken first and the heat temperatures later. It was found that the criticism was unfounded and that the initial temperature readings could be relied on.

Surface temperature readings of those parts of the body which were completely covered by bed clothing were taken to determine the uncomplicated effect of exposure on the skin temperature. A comparison of the average skin temperatures (positions 7 to 15 inclusive) during exposure to room temperature, with readings taken under the clothing, is shown in Table 3.

In all cases there was a decrease in the skin temperature, especially in the first few minutes. This fall in the skin temperature was apparently due to the sudden increase in the difference between the temperature of the skin and that of the air surrounding it, this greater temperature gradient allowing the surface heat to pass more rapidly into the surrounding air.

TABLE 3.—*Effects of Different Lengths of Exposure on Average Skin Temperatures of the Body of Five Normal Children* *

Case	O. S.	K. S.	Y. M. †	H. R.	E. B.
Covered	35.4	34.1	34.4	34.2	35.1
Exposed one-half to 1 minute	33.9	33.4	33.3	33.4	34.2
Exposed 6 to 14 minutes	32.8	31.9	32.3	32.4	....
Exposed 18 to 27 minutes	31.9	31.5	31.9	32.2	33.4
Exposed 30 to 38 minutes	31.6	31.1	31.5	32.1	32.4
Average room temperature	21.3	21.0	22.9	24.1	24.4

* This table is made up of temperatures taken at locations ordinarily covered with clothes, Nos. 7 to 15 inclusive.

† It should be noted that these averages differ from those given for the same case in Table 2, which includes the uncovered as well as the covered parts of the body.

Although there was an immediate fall in the temperature in all cases during the first minute of exposure, it did not continue to fall with the same rapidity in every instance. For example, in Case H. R. there was only a slight decrease in the temperature after fourteen minutes, which suggests that some regulatory factor came into play which prevented any further marked lowering of the skin temperature. This may be contrasted with Case E. B., whose skin temperature fell continuously during the entire period of exposure to the same room temperature. Although the temperature reading in the interval between six and fourteen minutes is missing, it has been assumed that the temperaure fell at that time as it did in the other cases. Although the average skin temperatures were lower at the end of the half hour of exposure than at the beginning in all instances, there was a slightly greater difference when the temperature of the room was 21 C. than when it was 24 C.

When there is little difference between the temperature of the skin and the surrounding air, the skin temperature may not fall on exposure. This happened in the case of an infant (not included in the beforementioned group) who, exposed for fifteen minutes in a surrounding temperature of 30 C., showed no appreciable lowering of the temperature of the skin. It would seem then that the fall in the skin

temperature during exposure is dependent on the degree of difference between the surface temperature and that of the surrounding air, other factors being equal.

SUMMARY

Skin temperature readings in five normal children were made with the thermo-electric couple, so far as possible, under uniform conditions. It was found that the temperature of the skin under clothing varied, that of the trunk being higher than the extremities and exposed parts of the body.

The same group of children were exposed to room temperature, and when the clothing was removed there was an immediate fall in the skin temperature. In some instances the skin temperature continued to fall definitely during a half hour without any change in rectal temperature, while in others there was very little, if any, fall after fifteen minutes. This seems to indicate that the skin as an organ has some power of regulating the rate in which the heat is transported to it, and is able to prevent heat loss just as it is able to accelerate heat loss by perspiration.

SKIN TEMPERATURE AND BASAL METABOLISM DURING FASTING*

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In a previous paper, the skin temperatures of normal children measured with the thermo-electric junction were presented and discussed. The present study presents skin temperature measurements and basal metabolism determinations of four children with idiopathic convulsions, obtained before and during therapeutic fasts of seven to fourteen or more days. Comparisons were made of the heat production, the temperature of the skin, the pulse rate and the blood pressure, in an attempt to estimate the quality and quantity of the changes which take place during fasting. The blood chemical changes in these children, showing the diminution in the glycogen reserve and the onset of a compensated acidosis, have been reported in an earlier communication.[1]

The ages of these four children varied from 11 to 13½ years. Physical examination and exhaustive laboratory tests failed to show any abnormality other than poor posture. But for the history of convulsive attacks, they would have passed as physically normal children. Their history and clinical data can be found in a report from this clinic by Shaw and Moriarty.[1]

Measurements were made of the skin temperatures under the clothing on the morning the fast was commenced, and again as near as possible to the last day of fast. The same amount of blankets and the same care in covering were used in each case. The basal metabolism was determined on the same day as the skin temperature measurements, except as noted in the tables. So far as it was possible to control, conditions were uniform.

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* Read before the American Pediatric Society, Washington, D. C., May, 1925.
* From the Children's Medical Department, Massachusetts General Hospital, and the Department of Pediatrics, Harvard Medical School.
* This paper is No. 56 of a series of studies in metabolism from the Harvard Medical School and allied hospitals. The expenses of this investigation have been defrayed in part by a grant from the Proctor Fund of the Harvard Medical School for the study of chronic diseases.

1. Talbot, F. B.; Shaw, E. B., and Moriarty, M. E.: Hypoglycemia and Acidosis, J. A. M. A. **83**:91 (July 12) 1924. Shaw, Edward B., and Moriarty, Margaret E.: Hypoglycemia and Acidosis in Fasting Children with Idiopathic Epilepsy, Am. J. Dis. Child. **28**:553 (Nov.) 1924.

The basal metabolism was determined with the same precautions taken in previous work in this laboratory.[2] Coincident records of the pulse rate, blood pressure and body temperatures were made. The results are correlated in Tables 1 to 4, inclusive.

All the patients lost weight during the fast: from 2.7 to 4 kg. in those who fasted seven to eight days, and nearly 5 kg., or one sixth of the total weight, in the case of W. P. during a fast of two weeks. There was a coincident fall in the pulse rate in all the patients, but it was greatest in Case 3 on the fourteenth day of fast, and was accompanied in Cases 1 and 3 by a fall in the systolic blood pressure.

Cases 1, 2 and 3 showed a distinct lowering of the average skin temperature, it being lower as the fast progressed. In Case 3, it was 3.5 C. cooler on the fourteenth day of fast than on the morning the fast was commenced. It is surprising that these children did not complain of cold. It was found, however, that when exposed to room temperature they felt the cold quicker and noticed sensations of cold earlier than did the normal children.[3] Although the surface of the body was colder at the end of fast than at the beginning, the temperature of the inner body, as measured by the rectal temperature, showed little difference and was maintained at a slightly elevated level. One patient (Case 4) showed only a slight change in either the skin temperature, the rectal temperature or the basal metabolism.

SKIN TEMPERATURE AND BASAL METABOLISM

The basal metabolism (basal in average of two well agreeing one-half hour periods inside the child cot chamber) was determined on the same day, in order to measure the heat production and to determine its relation to the skin temperature. Since the temperature measurements of the skin and the metabolism were both determined under "basal" conditions, comparisons of change in each are justifiable. The basal metabolism, like the skin temperatures in Cases 1, 2 and 3, was definitely lower on the last day of fast than on the control day. A lessened heat production, therefore, was accompanied by a lowered skin temperature.

The apparent interrelationship between the skin temperature and the basal metabolism seems also to hold in Case 4, in which there was very slight if any fall in the basal metabolism and less definite lowering of the skin temperature than in the other cases. Cases 1, 2 and 3, therefore, showed lessened heat production along with the lowered skin temperature, while Case 4 showed little or no lowering of the

2. Publication of Carnegie Institution of Washington, Nos. 201, 233 and 302.
3. See Talbot, Dalrymple and Hendry: Skin Temperatures in Normal Children, this issue.

TABLE 1.—*(Case 1). P. G., a Girl, Aged One and a Half Years, Underwent an Eight Day Fast in February, 1924*

Date	Day of Fast	Ht., Cm.	Wt., Kg.	Pulse	Blood Pressure	Temperature Av. Skin† C.	Temperature Rectal C.	Temperature Room C.	Humidity, %	Basal Metabolism Total Cal., 24 Hrs.	Basal Metabolism Per Sq. M., 24 Hrs.
Feb. 11	Post-absorptive *	136	32.06	98	108/82	32.02	37.8	23.0	46	1,306	1,112
Feb. 18	8	136	29.02	76	98/76	30.91	37.3	23.0	45	985	985

* Twelve hours after last food.
† Average of positions 1–17. See Talbot, Dalrymple and Hendry: Skin Temperatures in Normal Children, this issue.

TABLE 2.—*(Case 2). C. P., a Boy, Aged 13 Years, Underwent a Seven Day Fast in December, 1923*

Date	Day of Fast	Ht., Cm.	Wt., Kg.	Pulse	Blood Pressure	Temperature Av. Skin† C.	Temperature Rectal C.	Temperature Room C.	Humidity, %	Basal Metabolism Total Cal., 24 Hrs.	Basal Metabolism Per Sq. M., 24 Hrs.
Dec. 4	Post-absorptive	138	37.73	90	110/90	33.38	37.4	22.1	68	1,305	1,008
Dec. 17	7	138	33.03	80	108/88	30.88*	37.2	21.6	46	1,031	867

* December 18.

TABLE 3.—*(Case 3). W. P., a Boy, Aged 11 Years, Underwent a Fourteen Day Fast in December, 1923*

Date	Day of Fast	Ht., Cm.	Wt., Kg.	Pulse	Blood Pressure	Temperature Av. Skin† C.	Temperature Rectal C.	Temperature Room C.	Humidity, %	Basal Metabolism Total Cal., 24 Hrs.	Basal Metabolism Per Sq. M., 24 Hrs.
Dec. 4	Post-absorptive	135.5	31.36	88	120x74	34.08	38.0	22.5	65	1,425	1,246
Dec. 18	14	135.5	26.48	52	108/82	30.60	37.2	21.3	45	929*	922

December 17.

TABLE 4.—*(Case 4). H. A., a Boy, Aged Thirteen and a Half Years, Underwent an Eight Day Fast in February, 1924*

Date	Day of Fast	Ht., Cm.	Wt., Kg.	Pulse	Blood Pressure	Temperature Av. Skin† C.	Temperature Rectal C.	Temperature Room C.	Humidity, %	Basal Metabolism Total Cal., 24 Hrs.	Basal Metabolism Per Sq. M., 24 Hrs.
Jan. 24	Post-absorptive	142	30.05	95	124/86	32.55*	37.0	24.6	44	1,052	912
Feb. 5	8	142	27.33	87	118/88	31.99	37.3	24.0	53	978	919

January 23.

heat production and only slight lowering of the skin temperature. This seems to indicate that, other factors being eliminated, the temperature of the surface of the body depends on the amount of heat formed within it.

Benedict, Miles, Roth and Smith [4] found, in their group of men who underwent a prolonged restricted diet, results consistent with those reported in the foregoing. They tested the skin temperature of the hands and forehead of their patients, and found a low temperature with the surface of the hand with considerable regularity in some of them. This, added to the fact that they had a distinctly lowered heat production and a decreased pulse rate, is consistent with the conclusions arrived at by us.

The following hypothesis is offered in explanation of these findings. The skin which covers the surface of the body contains a network of capillaries, through which the warm blood is carried to the skin surface. An important function of the circulation is to transport heat to the skin where it is lost to the surrounding air. The transportation of heat is controlled to a great degree by the rate of the capillary circulation, which, as Krogh and others have shown, is affected by various factors such as heat and cold. It seems probable that the diminished heat production, due to the lack of food energy in these fasting children, was an expression of the body's attempt to conserve the body tissues and energy.

Chemical studies [1] on the blood of these children have shown that the circulating sugar of the body is markedly diminished, and measurements of the respiratory quotient that the greater part of the heat energy was derived from body fat. This is taken to indicate that the body reserves of glycogen have been used up and that the fat reserves are being depleted. Protein, which is the principle component of the important organs of the body, was only called on in small amounts sufficient to supply the antiketogenic factor necessary in the combustion of fat. It is clear then that if heat production continued at the same rate as during ordinary life the energy reserve of the body would be more rapidly used up. The lowered basal metabolism in the first three cases is interpreted, therefore, as an attempt to conserve body energy; the patient known as Case 4, on the other hand, was extravagant and continued to use up energy at the same rate as before the fast was commenced. The lowered skin temperature was due to an effort of the body to retain body heat, to hold it within the body, in which the organs important to life are situated in order to maintain them at their

4. Benedict, Miles, Roth and Smith: Human Vitality and Efficiency Under Prolonged Restricted Diet, Carnegie Inst., Washington, 1919, No. 280.

most efficient temperature. This was favored by a slower rate of circulation as evidenced by the pulse rate, and presumably a slower transportation of heat from the interior to the surface of the body.

CONCLUSIONS

During fasting, the rate of heat production in the body, as measured in the child cot chamber, usually diminishes. It fell more in a fourteen day fast than in an eight day fast.

The skin temperature became lower during the fast, and, in general, presented a curve similar to that of the basal metabolism; the longer the fast the greater the fall in the skin temperature of these patients.

The pulse rate was usually lowered, and the blood pressure sometimes definitely lowered. This is associated with a tendency for the skin to become pale or slightly cyanotic if not well covered with clothing or blankets.

BLOOD CHEMISTRY OF THE NEW-BORN

IN HEALTH AND IN INANITION FEVER *

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In reviewing the literature on the blood chemistry of the new-born, it was found that there were only sporadic data on the chemistry during the first few days of life and none of a comparative nature on the first, third and fifth days. Although a great deal of work has been carried out on certain selected constituents of the blood during inanition fever, such as studies on blood concentration and chlorids, no systematic comparison is available between normal new-born infants and inanition cases. In 1922, we presented a preliminary report on the blood chemistry of the new-born; this paper is a detailed and extended account of the comparison of the blood chemistry of the normal new-born and those suffering from inanition fever.

EXPERIMENTAL PART

Clinically healthy babies were chosen for the data on normal infants, precautions having been taken that these infants had sufficient fluid and food intake. Only those having a rectal temperature between 97.0 and 99.5 F. and those who showed no abnormal loss in body weight were considered normal. The values for the first day were on cord blood while the data on the third and fifth days were obtained from the fontanel.

In the fever cases the babies were deprived of all supplemental fluid intake, receiving only a limited supply of milk from the breasts. Samples were taken on the third and fifth days if a temperature higher than 100 F. had been attained.

Standard methods of analysis were employed, using the Folin and Wu filtrate for amino-acids, sugar and chlorids. Urea was determined on the whole blood and carbon dioxid by the method of Van Slyke. Water was determined by drying a weighed sample of oxalated blood at 75 to 80 C.

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* Contributions from the Department of Laboratories of the Buffalo General Hospital and from the Department of Biological Chemistry, University of Buffalo Medical School.
* Read before the American Pediatric Society, Washington, D. C., May 4, 5 and 6, 1925.

Table 1, giving averages, and Table 2, giving details, show the comparative values of the blood chemistry of normal new-born babies for the first, third and fifth days.

It will be observed that the values for urea nitrogen vary only slightly during the periods studied. The average values are somewhat higher than those reported by Howe and Givens.[1]

The carbohydrate content of the blood falls slightly after the first day, and there is no appreciable change after that time. The sodium chlorid content of the whole blood of the normal new-born infant is definitely higher on the first day and reaches a constant level on the third day.

The amino-acids show a change similar to that of sugar and chlorids, being higher in cord blood and coming to a constant level on the third day. The average values for amino-acids on the cord blood agree with the data of Morse [2] for fetal blood. The average values on the third and fifth day are somewhat higher, 7.86 mg. as against 5.56 mg. obtained for older infants by Hoeffel and Moriarty.[3]

The carbon dioxid combining power of the blood expressed in millimeters, so as to be comparative with carbon dioxid tension of alveolar air, is low in the cord blood and gradually increases up to the fifth day. (The normal value of carbon dioxid in alveolar air was chosen as 35 mm.) The data of Seham [4] on alveolar air analyses of the new-born do not indicate regular changes in the alveolar carbon dioxid from the first to the fifth days, but on account of the variations of his figures it is difficult to draw accurate conclusions. Our data show that after the fifth day the plasma bicarbonate parallels the alveolar carbon dioxid tension. Thus on the fifth day we obtain an average of 32 mm. while Seham's averages are 38 mm.

The percentage water calculated from the total solids is quite constant during the period studied, the average values being lower than those reported by Courtney and Fales [5] and by Lust.[6] These investigators obtained an average of 82 per cent. water against our average of 79.3 per cent.

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1. Howe, M. G., and Givens, M. H.: Chemical Studies of the Blood of Mother and Fetus, Am. J. Dis. Child. **25**:63 (Jan.) 1923.

2. Morse, A.: Bull. Johns Hopkins Hosp. **28**:199 (June) 1917.

3. Hoeffel, G. F., and Moriarty, M. E.: Amino-Acid Content of Blood of Infants and Children, Am. J. Dis. Child. **27**:64 (Jan.) 1924.

4. Seham, Max: The Acidotic State of Normal New-Borns, Am. J. Dis. Child. **19**:42 (July) 1919.

5. Courtney, A. M., and Fales, H. L.: Variations in Infants of Total Blood Solids and the Concentration of Sodium Chlorid in the Plasma, Am. J. Dis. Child. **14**:202 (Sept.) 1917.

6. Lust: Jahrb. f. Kinderh. **73**:85, 173, 1911.

TABLE 1.—*Averages of the Blood Chemistry of the New-Born*

	Urea Nitrogen			Sugar			Chlorids			Amino-Acids			Carbon Dioxid, Mm.			Percentage Water		
	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day
Averages, 23 cases normal babies	15.1	15.85	14.9	115.4	97.7	98.7	552	492.4	490.7	9.56	7.45	7.86	20.4	26.56	31.81	79.5	79.1	79.54
Averages, 19 cases newborn infants with fever	16.72	37.3	41.99	112	96	96.7	509.7	519	513	10.4	12.46	10.87	23.25	18.33	17.75	80.8	79.69	78.5

TABLE 2.—*Normal Infants*

	Urea Nitrogen			Sugar			Chlorids			Amino-Acids			Carbon Dioxid, Mm.			Percentage Water		
No.	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day
1	19.5	16.8	18.0	115	100	100	520	506	500	17.5	10.0	9.0	25.0	24.0	32.0	73.0	78.5	78.5
2	14.7	16.0	18.1	125	105	90	700	490	480	10.0	8.8	8.0	19.0	23.0	33.0	79.1	76.4	76.0
3	22.0	17.0	16.8	...	100	95	766	506	500	8.0	8.5	7.8	12.0	....	28.0	77.0	76.0	77.1
4	13.3	....	14.2	115	...	100	574	500	500	10.0	7.5	8.0	20.0	....	31.0	80.0	....	79.0
5	10.5	20	9.1	120	98	99	500	502	490	....	9.0	7.8	23.8	27.0	32.7	81.0	83.0	80.5
6	17.5	17.0	18.0	125	101	90	435	440	440	7.7	8.0	7.1	15.0	....	28.1	81.0	80.0	80.5
7	16.1	16.0	15.5	...	...	...	555	514	507	8.3	7.0	6.1	22.7	....	34.0	....	79.1	80.0
8	15.0	18.1	14.0	110	90	99	...	510	514	....	....	...	23.0	27.0	34.0	81.0	77.5	77.1
9	14.0	16.8	12.0	114	100	90	...	500	506	....	6.5	8.1	25.0	31.8	33.2	....	80.9	82.0
10	11.9	13.0	13.4	...	100	95	...	490	500	....	7.0	8.1	20.0	....	32.1	75.0	76.1	76.0
11	12.0	12.9	11.9	100	91	100	500	491	498	8.0	8.1	7.7	....	....	....	81.0	79.8	80.3
12	14.0	....	15.0	...	...	92	...	...	...	....	....	8.0	....	....	....	82.0	....	82.0
13	15.4	....	15.1	...	...	100	...	...	501	....	....	...	....	....	....	83.0	....	82.3
14	14.0	15.1	13.9	110	100	100	514	505	509	8.9	8.0	7.3	....	....	....	82.0	82.0	82.5
15	16.8	....	17.1	...	...	...	...	...	...	10.0	....	8.8	....	....	....	83.3	....	82.7
16	16.8	15.0	....	...	...	...	...	...	501	....	....	8.1	....	....	....	78.0	....	78.0
17	12.0	13.1	....	...	...	...	...	...	...	8.8	7.9	...	....	....	....	80.7	81.0	....
18	15.4	16.0	16.7	120	90	93	516	506	500	8.0	8.7	8.0	....	....	....	79.6	75.0	78.0
19	18.0	17.1	17.0	...	...	97	514	519	510	9.5	8.4	8.0	....	....	....	78.0	78.0	80.0
20	17.0	16.5	15.0	...	...	...	500	508	508	....	....	...	....	....	....	80.1	78.5	77.0
21	14.0	13.9	15.0	...	...	...	574	521	520	9.2	7.5	7.9	....	....	....	80.0	83.0	83.5
22	15.4	15.0	15.1	...	...	100	598	506	424	10.0	8.3	7.8	....	....	....	80.67	79.0	76.0
23	12.1	....	14.1	...	...	...	520	450	406	....	....	...	....	....	....	82.0	81.1	81.5

The data before mentioned show that the blood chemistry of the normal new-born after the third day is within the range of the averages reported for the normal adult.

BLOOD CHEMISTRY OF FEBRILE BABIES

Table 1, giving averages, and Table 3, giving details, present the blood chemistry of febrile babies. It will be observed that the values recorded on the cord blood of these infants agree with the averages of the data presented in Table 1. This shows that the patients examined were normal at birth and any changes recorded on the third and fifth day were induced by the curtailed fluid and food intake.

In reviewing this table, it will be noted that striking changes occur in the urea nitrogen and amino-acid fractions. In all of the febrile cases there is a very pronounced increase in the blood urea nitrogen. The amount of the increase seems to fluctuate with the changes in the temperature of the new-born. Thus in Cases 1 and 3, the urea nitrogen is lower on the fifth than on the third day. In both of these instances the temperature of the infants on the fifth day had almost returned to normal. On the other hand, Cases 2 and 15 show a gradual rise of urea from the third to the fifth day. The temperature of these infants was at its maximum on the fifth day. We also find the highest urea nitrogen in those infants with the highest temperature. Thus Case 9 had the highest fever of any of the infants studied and showed the greatest increase of urea nitrogen. This increase of urea nitrogen in the new-born is similar to the increase in nonprotein nitrogen reported by Bacon, Novy and Eppler [7] for animals suffering from dehydration fever produced by diuresis. However, as will be pointed out in another paper in which experiments on new-born puppies were carried out, the increase of urea nitrogen in inanition is probably due to factors other than the rise of the temperature.

Our data show no appreciable changes in the blood sugar during the periods examined. This is undoubtedly due to the fact that the infants were not completely starved but were receiving sufficient breast milk to prevent a depletion of glycogen reserve, since data of other investigators indicate that during starvation infants show a marked fall of blood sugar.[8]

Many investigators [9] have reported an increase of blood chlorids in inanition fever and have tried to relate the fever to the increased salt content. Our data during fever show only a small increase in chlorids

7. Bacon, D. K.; Novy, F. O., and Eppler, H. H.: Factors in Leukocytosis, Arch. Int. Med. **30**:229 (Aug.) 1922.

8. Franz, R.: Jahrb. f. Kinderh. **105**:321, 1924.

9. Schonfeld, H.: Arch. f. Kinderh. **72**:120. Vollmer, H.: Ztschr. f. Kinderh. **36**:234; **37**:752.

TABLE 3.—*Febrile Cases*

No.	Urea Nitrogen			Sugar			Chlorids			Amino-Acids			Carbon Dioxid, Mm			Percentage Water		
	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day	First Day	Third Day	Fifth Day
1	17.0	27.9	20.3	109	100	95	517	510	490	12.0	9.6	10.1	....	20.0	21.0	80.9	77.6	77.0
2	12.6	21.7	31.5	110	95	95	453	450	480	10.7	9.1	9.5	22.7	20.0	18.0	80.5	75.6	77.1
3	11.9	26.6	17.5	110	80	93	505	500	503	10.8	10.0	10.0	23.8	15.0	21.0	81.1	83.0	80.5
4	13.5	21.0	....	114	100	...	...	506	...	11.0	7.8	....	....	....	....	83.0	89.0	....
5	....	45.4	....	...	95	...	...	514	...	....	11.5	....	....	21.1	....	....	84.8	....
6	....	33.6	....	...	100	...	...	510	...	....	9.0	....	....	21.0	....	....	72.0	....
7	....	55.9	....	...	98	...	...	565	...	....	36.3	....	....	23.8	....	....	79.8	....
8	....	48.9	....	...	...	...	...	520	...	....	12.6	....	....	15.0	....	....	79.5	....
9	Twelfth day		155	...	...	...	...	570	...	....	15.0	....	....	15.5	....	....	81.4	....
10	13.0	....	27.3	120	...	99	...	...	506	9.5	....	10.0	....	....	....	80.1	....	78.0
11	26.6	53.0	....	115	100	...	518	452	...	10.0	9.5	....	....	19.9	....	77.2	73.1	....
	....	....	64.4	...	...	55	...	...	500	....	....	12.0	....	....	....	....	....	75.4
12	....	....	47.6	...	...	100	...	...	494	....	....	13.0	....	....	11.0	....	....	77.5
13	....	30.0	....	...	96	...	...	...	556	....	10.6	....	....	12.0	....	....	80.05	....
14	17.5	....	44.8	110	...	100	540	...	536	10.0	....	10.1	....	....	....	81.5	....	80.8
15	18.0	32.2	93.6	124	100	100	...	618	598	....	11.0	13.0	....	....	....	82.0	80.1	79.9
16	18.1	58.0	....	100	92.7	...	530	514	...	....	10.0	....	....	....	....	....	78.5	....
17	....	31.1	....	...	...	...	491	...	...	....	....	....	....	....	....	....	81.3	....
18	17.0	....	57.4	...	...	...	500	...	474	9.5	....	10.2	....	....	....	81.4	....	80.7

(1 per cent.), which is well within the limits of error of the method employed. These data indicate, in our cases at least, that fever is independent of the chlorid increase and lead one to believe that the chlorids are not important factors in the production of inanition fever.

Goebel [10] reports a large increase in amino-acids in infants during prolonged starvation. After seventy-two hours of starvation the value in one case on the fourth day was 46 mg. per hundred cubic centimeters. Our data confirm this observation and indicate that there is a very marked rise in the amino-acid nitrogen only in the severe cases of inanition fever. Thus Cases 7 and 9, with a temperature of 103 and 104 F. respectively, had an amino-acid nitrogen of 36 and 15 mg. per hundred cubic centimeters. This increase of amino-acid nitrogen in the febrile babies is very remarkable when one considers that in the adult at least it is very rare to obtain a change in the blood amino-acid nitrogen, even in extreme pathologic conditions.[11]

During the inanition fever periods, our data show a diminished alkaline reserve sufficient to produce a decided acidosis, which confirms the data of Scheff, Eliasberg and Bayer.[12] The factors which cause this diminution of the alkali reserve have not as yet been investigated.

Great emphasis has been laid on the concentration of the blood during inanition fever, due chiefly to the work of Marriott,[13] and of Lucas and Dearing.[14] Bakwin [15] and his collaborators [16] have continued these studies, using mainly refractometric methods for calculating concentration changes in the blood. These investigators find that in inanition fever there is an increase concentration of the blood based on the increase of plasma proteins, and that coincident with the fall of temperature there is a decrease of plasma proteins.

It does not seem to us, however, that Bakwin's data are conclusive, because of some of the assumptions in the refractometric method. In the first place, this method assumes that the serum proteins are present in the blood in the same concentration normally and during inanition

10. Goebel, F.: Ztschr. f. Kinderh. **38**:27, 1924.

11. Greene, C. H.; Sandiford, K., and Ross, H.: J. Biol. Chem. **58**:845 (Jan.) 1924. Feinblatt, H. M., and Shapiro, I.: The Amino-Acid Content of Blood in Various Pathologic Conditions, Arch. Int. Med. **34**:690 (Nov.) 1924.

12. Scheff, E.; Eliasberg, H., and Bayer, W.: Jahrb. f. Kinderh. **106**:263, 1924.

13. Marriott, M. W.: Some Phases of the Pathology of Nutrition in Infancy, Harvey Society Lectures, 1920-1921.

14. Lucas, W. P., and Dearing, B. F.: Blood Volume in Infants Estimated by the Vital Dye Method, Am. J. Dis. Child. **21**:96 (Jan.) 1921.

15. Bakwin, H., and Goss, C.: Dehydration in New-Borns, I. Am. J. Dis. Child. **24**:497 (Dec.) 1922. Bakwin, H.: Ibid. II **24**:508 (Dec.) 1922.

16. Bakwin, H., and Morris, R. N.: The Leukocyte Count in the New-Born with Dehydration Fever, Am. J. Dis. Child. **26**:23 (July) 1923; The Effect of Fluid on the Temperature and Blood Concentration in the New-Born with Fever, Am. J. Dis. Child. **27**:578 (June) 1924.

fever. Hence any variations which occur in the febrile cases are not due to actual changes in the amount of proteins present, but to addition or subtraction of the water. Bakwin and his collaborators have not included, in their published papers, the actual determinations of serum proteins in normal infants as compared to those suffering from dehydration fever. Secondly, in order that the refractometric method be accurate, the assumption must also be made that the other constituents of the blood plasma do not vary greatly under the imposed experimental conditions. Now our data clearly show that the blood chemistry of the new-born with inanition fever is different from that of the normal new-born, particularly with regard to large increases in concentration of urea and amino-acids. These factors must be taken into consideration if refractometric determinations are to be of the greatest value. Consequently, to interpret correctly the refractometric changes in the serum proteins, a simultaneous blood chemistry should also be recorded. Unfortunately, at the time this work was performed, we did not have the equipment for refractometric measurements. Until such a comparison is available the conclusions of Bakwin and his collaborators should be evaluated conservatively. Furthermore, comparative values are not available on blood volumes and serum proteins in normal and dehydrated babies. Deductions from the data of Bakwin[17] on the blood volumes of normal and marantic infants cannot be applied to the new-born in the first few days of life on account of age discrepancies. However, it is interesting to note that the averages of the changes in serum proteins in Bakwin's marantic children are much greater than might be expected from the average fluctuation in blood volumes. Thus the serum protein in the marantic patients is increased on an average of 8.4 per cent., while the averages of the blood volume are increased 1.1 per cent. In other words, the serum proteins show a decided blood concentration while the blood volume determinations show a slight dilution of the blood in infants with nutritional disturbances. A similar discrepancy is shown if only infants of approximately the same ages are compared, that is, between 2 to 4 months. Here again Bakwin's data show no appreciable change in blood volume (0.3 per cent.), while the estimation of serum proteins indicate a marked blood concentration (6.36 per cent.).

In our experiments, the total water content of the blood was calculated from the total solids. This, of course, is only a very rough index of blood concentration. Nevertheless, if Bakwin's refractometric data are taken as standards, the dehydrated babes should show a very marked increase of total solids, an average of 30 per cent., with a minimum of 7 per cent.

17. Bakwin, H., and Rivkin, H.: The Estimation of the Volume of Blood in Normal Infants and in Infants with Severe Malnutrition, Am. J. Dis. Child. **27:** 340 (April) 1924.

Our data do not indicate any such marked changes in the total solids. The average of babies with inanition fever is identical, within the limits of experimental error, with the average values for normal babies. In only five out of nineteen cases of fever was there an increase in total solids above the normal average of the new-born infants. The increase, moreover, in all these cases, was not above 7 per cent., well within the limits of error of the method employed. In general, the foregoing data have a tendency to indicate that the changes in blood volume are in the direction of increased water addition to the blood, which is not inconsistent with the blood chemistry findings. The increased nonprotein nitrogen of the blood in the febrile cases would raise the osmotic pressure of the blood, and hence have a tendency to cause migration of fluid from the tissues to the blood stream. However, to settle this point conclusively, a great deal of correlative evidence is still necessary.

SUMMARY

1. Comparative data on the blood chemistry of new-born infants (twenty-three cases) on the first, third and fifth day are presented.

2. In so-called inanition fever there is a marked increase of blood urea nitrogen and amino-acids.

3. There is marked acidosis, as shown by the marked decrease in carbon dioxid combining power.

4. There is no decrease in the percentage water content of the blood, as measured by the total solids.

5. These so-called inanition fevers apparently are not due to increased salt concentration of the blood.

LIGHT AND THE ANTIRACHITIC FACTOR*

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Our purpose is to compare clinical experiences and observations of the action of light on different diseases, with corresponding observations from the laboratory of the effect of light on some experimentally produced diseases in animals, and thus contribute to our knowledge of the relation between light and some of the vitamins, especially the so-called antirachitic vitamin and vitamin A substance.

The experiments on animals were, for the most part, carried out in American and English laboratories, and the results have been published during the last few years.

EXPERIMENTS

The clinical experiments were made at the Danish State Hospital. Even when it was opened in 1910, a room was equipped for giving Finsen light baths (carbon arc light with two lamps of 75 amperes). When we heard of the excellent results obtained by Reyn and his collaborators in the treatment of surgical cases of tuberculosis with the carbon arc light, we started the same treatment at the State Hospital in 1914, at first for tuberculous glands, which is the most common form of tuberculosis at the children's hospital. The effect was indubitable; it was particularly surprising in some cases of tabes mesenterica. Among these was a case in which the abdomen was full of hard nodular masses of glands. Under the light treatment they shrank and gradually disappeared, while the general condition at the same time improved in a remarkable degree.

It therefore occurred to us to investigate whether artificial light would also affect the chronic diseases which appear chiefly during the winter, and disappear spontaneously during the summer. According to our ideas at that time these were principally rickets, the tetany of children and simple anemia.

During the winters of 1914, 1915 and 1916, several patients with florid rickets were treated with the carbon arc light for one-half to one hour daily. Their condition was cured or improved in a few weeks; among them were patients treated with the light only, without the simultaneous administration of cod liver oil. The investigations, how-

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* From the Children's Department of Rigshospitalet, University of Copenhagen.
* Read before the Medical Society of Copenhagen, Jan. 13, 1925.

ever soon had to be curtailed, and later—after the declaration of the unrestricted U-boat campaign—entirely suspended, because the threatened shortage of coal during the War made it necessary to economize on electricity. We, therefore, did not obtain any definite result as the experiments were too few.

At that time we were unacquainted with phosphorus determinations in the blood, and even the roentgen-ray diagnosis of rickets was not fully developed. It was therefore difficult to come to any conclusion about the result of the treatment, since clinical rickets often apparently disappears spontaneously after a change of diet or the transference of the patient to other surroundings, and the majority of patients are cured independently of all treatment during the summer. In Germany, however, they had begun to use light baths with mercury-quartz lamps for several different diseases. A number of papers appeared, in 1919 and 1920, reporting that this treatment had a marked curative action in rickets. Huldschinsky was the first to observe this, and later it was confirmed by all investigators. Not only did the ordinary clinical examination show that the light had this effect, but the roentgen-ray investigation and the methods now worked out for determining the phosphorus content of the blood, also showed it.

OTHER EXPERIMENTS

The demonstration of the fact that the phosphorus content of the blood is decreased in florid rickets and that an increase in it is the first sign of cure, is due to Paul Iversen, Lenstrup, John Howland and Kramer. The Danish contribution appeared first, but dealt with a small number of cases. The American investigation was independent of the Danish and was more extensive, for it not only included more cases, but also a greater number of morbid conditions. This discovery brings us a considerable step further in our knowledge of rickets, and it affords us a measure of the intensity of the disease and of the effect of treatment.

These facts also apply to some extent to experimental rickets, which can be produced in growing animals in several apparently different ways. Findlay (Glasgow) has caused rickets in puppies by merely confining them in narrow cages. Mellanby (Lister Institute) produced rickets more constantly in puppies by keeping them on a diet which was poor in the vitamin A, but which contained an abundance of carbohydrates. The most straightforward and constant results, however, were obtained by McCollum and his collaborators. They caused rickets in young rats by decreasing the content of the food in phosphorus and also by decreasing its content in calcium, giving, at the same time, a limited supply of vitamin A in each instance. The form produced by with-

holding phosphorus from the food particularly resembles clinical rickets. Moreover, as it is easy to produce, this is the special form which has been used for experimental purposes.

A number of experiments by Alfred F. Hess, Unger and Pappenheim and McCollum, Shipley, Park and Nina Simmonds carried out at about the same time and all pointing in the same direction, prove that sunlight, the carbon arc light and the mercury-quartz light each exert a strong protective action against this form of rickets even if they are allowed to act only for a few minutes daily, and that the antirachitic effect is due entirely to the ultraviolet rays. At the Finsen Institute, Schultzer and Sonne have found that the rays possessing the antirachitic properties lie between 400 and about 280 micron wavelengths. The light rays have hardly any action.

We know nothing of the way in which the light acts. We see that under the influence of the quartz light the organism is able to recover with the administration of a small dose of phosphorus. Without the administration of more phosphorus than before, the blood phosphorus, which was subnormal, becomes normal, the uncalcified tissue in the growing areas of the bones becomes calcified, and the rickets is cured.

A number of animal experiments made by McCollum and his co-workers, Alfred F. Hess and his collaborators, and by several other investigators have further proved that besides ultraviolet light and cod liver oil, some other substances, such as egg-yolk, extract of green leaves and a few fats, have a similar antirachitic effect. In this respect also there is a close parallel between this form of experimental rickets and the clinical disease.

The fact that the antirachitic factor is united with the same fatty bodies as the vitamin A substance, according to investigations by Ethel Marjorie Luce [1] at the Lister Institute, and that milk fat and especially the fat of milk obtained during the summer, also contain the antirachitic factor, led to the vitamin A substance and the antirachitic factor being regarded as identical. When this proved to be false, the view was put forward that the antirachitic factor was a special vitamin closely related to the vitamin A substance, therefore an organic substance just like the other vitamins. This conception of the existence of an antirachitic vitamin distinct from the vitamin A substance was advanced by McCollum [2] and his school, and is now held by the majority of workers.

For a clinician who has had the opportunity of observing and treatiny many cases of the different deficiency diseases, it is difficult, however, to believe that clinical rickets results from a lack of vitamins. It is a daily experience that only a few children have rickets while others

1. Luce, E. M.: Biochem. J. **18**:716, 1924.
2. McCollum, E. V.: J. Biol. Chem. **53**:293 (Aug.) 1922.

escape, although they have lived under similar conditions and have received the same food—nourishment which produces normal development in the majority. This indicates that the cause of rickets must be sought in the individual himself. The experiments on phosphorus retention before and after light treatment carried out by Orr, Holt, Wilkins and Boone [3] in John Howland's clinic, support this contention. Furthermore, both clinical and experimental rickets are, so far as is known at present, distinct from all hitherto recognized vitamin deficiency diseases in their reaction to ultraviolet light. Experimental investigations, therefore, have not yet solved the problem of the pathogenesis of clinical rickets.

CLINICAL INVESTIGATIONS

The clinical investigations hitherto made on the action of light on rickets are not all entirely sound and straightforward. Thus in many instances the experimental conditions before and during the light treatment were not uniform, so that the possibility arises that other factors besides the light have exerted an influence. Precisely the same thing applies to similar research concerning the action of light in tetany.

As we had an accurate measure of the intensity of rickets in the phosphorus determination and of the degree of tetany in the calcium determination, we undertook some investigations into the effect of light on patients with these diseases. Our investigations were made during the autumn months and during the winter, a season when there is not much sunlight in our country and when these conditions do not improve spontaneously.

The patient's diet consisted of milk and carbohydrates. It was about the same before, during and after the light treatment, and it was usually the same diet as that of children who were ill. No cod liver oil preparation was given which might affect the disease. The only change was the exposure to the mercury-quartz light every other day, beginning, as a rule, with five minutes daily. The blood phosphorus and calcium were estimated after eight hours' fasting.

We have determined the phosphorus and calcium content of the blood in about fifty children, all of whom exhibited the characteristic clinical signs of rickets or tetany, or who had both diseases at the same time. In a later contribution, one of us will give a more detailed account of the cases and method of investigation. Only the phosphorus and calcium estimations in a few uncomplicated cases will be discussed here, that is to say, only the case of children with rickets or tetany without complications of any kind, including diarrhea and infections.

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3. Orr, W. J.; Holt, L. E., Jr.; Wilkins, Lawson, and Boone, F. H.: The Calcium and Phosphorus Metabolism in Rickets, with Special Reference to Ultraviolet Ray Therapy, Am J. Dis. Child. **26**:362 (Oct.) 1923.

In agreement with all previous work, it will be seen that the blood phosphorus becomes normal under the influence of the quartz lamp. This effect occurred in the present cases within a month after a total exposure of about 100 minutes. We do not yet know how soon the effect begins; it probably varies in different cases, being governed by the severity of the disease.

These investigations prove that it is the light alone that causes the blood phosphorus to rise, and, as it remains present in normal amount even when the exposure to the rays is discontinued after a few times, this stable condition cannot be due to the fact that the light has contributed or liberated a missing substance, be it phosphorus or a vitamin, because these bodies are constantly used up during growth, and a new supply must therefore constantly be furnished. It is more likely that a depressed function is revived by the action of the light.

TABLE 1.—*Content of Acid Solution of Phosphorus in the Blood*

		Phosphorus		Light		Phosphorus	
Sex*	Age	Date	Mg. per 100 C.c. Serum	Total Number of Minutes	Number of Treatments	Date	Mg. per 100 C.c. Serum
♀	2 years	10/29/24	3.6	115	8	11/19/24	7.0
♀	1½ years	10/27/24	4.0	100	7	11/19/24	7.4
♀	9 months	10/29/24	3.5	95	7	11/19/24	6.8
♂	1¼ years	1/ 4/25	3.0	95	5	1/31/25	6.7

* In this column, ♀ indicates female, ♂ male.

LIGHT AND CURATIVE ACTION

The majority of investigations have shown that light—especially the mercury-quartz light—has the same curative action on tetany, the concentration of the blood calcium rising from subnormal to normal as a direct result of the light treatment. The discovery of the facts that we find the blood calcium decreased and that it increases with radiologic treatment, is due to John Howland and his collaborators, Marriott, Kramer, Tisdall and several others.

Our first experiments with the carbon arc light in the treatment of tetany were, as mentioned, carried out in 1914. We soon had to abandon them, however. The strong light and the heat acted too drastically on the children, who reacted with perilous attacks of laryngeal spasm or eclampsia. In our present experiments, therefore, we have employed the much less luminous mercury-quartz light which gives less heat, and in the severest cases we have given the children from 0.25 to 0.50 gm. chloral shortly before the exposure, so that they were somnolent during the treatment. In this way we entirely avoided the psychic shock, and the children had no attacks during the treatment. As a rule it was necessary to give chloral only the first time and only to those who had

the disease with particular severity. As stated, they received no other kind of medical aid, and their diet consisted of milk in various dilutions, just as when the disease was developing.

In all the cases, a marked effect on the blood calcium is observed and concurrently an almost instantaneous cure of the disease in less than a fortnight.

Ultraviolet light thus acts on tetany just as it does on rickets. After a few exposures of from five to twenty minutes, the amount of calcium in the blood rises to normal (it cannot be made to exceed this), and even before this has happened all clinical signs of the disease have disappeared. Clinical tetany is, therefore, soon cured by light treatment while clinical rickets disappears gradually, which is a natural consequence of the fact that the soft bone tissue requires some time to calcify. It will also be observed that the blood calcium remains normal even if the exposure to the rays is discontinued, in fact, when it has started to

TABLE 2.—*Calcium Content of the Blood*

		Calcium		Light		Calcium	
Sex*	Age	Date	Mg. per 100 C.c. Serum	Total Number of Minutes	Number of Treatments	Date	Mg. per 100 C.c. Serum
♂	7 months	11/12/24	6.7	65	5	11/26/24	10.8
♂	19 months	12/ 5/24	6.8	130	8	12/15/24	10.6
♀	6 months	1/15/25	6.5	45	3	1/24/25	9.5
♀	8 months	2/24/25	5.9	20	4	3/ 9/25	10.1

* In this column, ♀ indicates female, ♂ male.

rise it continues to do so, irrespective of whether the child is treated or not. All this bears a close analogy with the relation of phosphorus to rickets.

We know a little more about the cause of tetany than we do about the cause of rickets. The tetany which arises after extirpation of the parathyroid glands corresponds closely with clinical tetany, according to the latest work of Salvesen [4] and other authors. The theory that the disease is due to a hypofunction of these glands is therefore highly probable. The fact that tetany is aggrevated and latent tetany becomes manifest after the administration of alkali or during an infection can also be explained on the basis of such a theory.

In analogy with this and in harmony with its clinical characters, the cause of rickets must be an endogenous change, some modification of function. The most likely factor is decreased power either to assimilate phosphorus or to retain it, or to regulate the metabolism of phosphorus in the organism.

It is also more likely that ultraviolet light may have such a general stimulating influence on the organism that it could furnish or replace

4. Salvesen, Harold A.: J. Biol. Chem. **61**:443 (June) 1923.

different vitamins which are lacking. But if the light has this nonspecific effect, we should be able to demonstrate something similar concerning other functions.

LIGHT AND DIABETES

The internal secretion of the pancreas in diabetes mellitus would be most suitable for an investigation of this kind because we have an easily determinable index of this secretion in blood sugar estimations. Only those cases, however, in which some secretion still takes place are adapted to such an injury, that is, cases in which the islands of Langerhans still partly survive.

In Germany, where treatment with "die Künstliche Höhensonne" has been tried in numerous diseases, diabetes mellitus has been included, and from Pincusssen's [5] and Rothmann's [6] investigations there seems to be no doubt that in some cases the light has had an effect.

Before investigating whether the light has an influence on the blood sugar concentration in diabetic patients, it is first necessary to find out

TABLE 3.—*Blood Sugar Determinations*

Date	Fasting Blood Sugar	Light Bath, Minutes	Fasting Blood Sugar	Blood Sugar at 7 p.m.
December 4	155	10	105	250
December 6	170	20	120	260
December 9	155	30	170	220
December 11	180	40	145	245
December 13	175	60	175	260
December 16	155	60	130	205
December 18	195	70	155	...

how normal persons react. We therefore determined the fasting blood sugar in a number of nondiabetic children before and after light baths for different lengths of time, and found that it remained exactly the same. So far we have had opportunity to treat only two diabetic children with light. The first was a girl, aged 12, with severe diabetes. The fasting blood sugar was increased on a definite diet, and after the meals it rose during the day. After having assured ourselves from some days' observation that the blood sugar was keeping steady, light baths with the mercury-quartz light were given, beginning with ten minutes and rising to sixty minutes. The light bath was given in the morning, and the patient received the first meal some time later. The blood sugar was determined just before and a little after the light bath; each time, therefore, it was the fasting blood sugar.

The values found are given in Table 3.

5. Pincussen: Ztschr. f. d. ges. exper. Med. **26**:127, 1922.
6. Rothmann: Ztschr. f. d. ges. exper. Med. **36**:398, 1923.

There was usually, therefore, a distinct reduction in blood sugar after the light bath, just as after an injection of insulin (up to 3 or 4 units of insulin are required to produce a similar reduction), but on the day after food was taken the blood sugar rose again to the same values as before the treatment.

To what is this decrease due? As no more sugar than usual was excreted in the urine, and since the sugar can hardly be deposited in the tissues, there is no other alternative than that it must be oxidized, and in accordance with our present knowledge of the action of insulin (Lundsgaard and Holbøl), this can only have happened through an increased excretion of insulin by the pancreas.

We shall not enter further into the significance of light treatment in diabetes; we have not yet had sufficient experience. We shall merely state that ultraviolet light apparently has a stimulating influence on the internal secretion of the pancreas when this function is deficient.

COMMENT

That light has a favorable influence on blood production in simple anemia has been known for many years. Contributions on this subject have come especially from the sanatoriums of Switzerland, and in Denmark investigators at the Finsen Institute have confirmed it so far as artificial light is concerned. In cases of simple anemia in young children who have been treated with the carbon arc light at the State Hospital, a rapid rise in the amount of hemoglobin has also been observed, particularly a rise in the number of red corpuscles; this occurred at a time when we were still treating anemic patients with weak solutions of organic iron preparations. There are, moreover, a series of experimental investigations by Kestner[7] which show that treatment with the carbon arc light accelerates the regeneration of the blood.

CONCLUSIONS

From the present investigations and considerations thereon it appears, that: 1. Light and particularly ultraviolet rays have a stimulating effect on the organism, which chiefly benefits those functions that are depressed. The curative action of light on rickets and tetany can be explained by such a stimulating effect.

It is certain, however, that cod liver oil has the same healing action on rickets and tetany as light has, although the former, in the quantities that can be given to children, acts more slowly and less surely than light.

2. As this effect is not due to the vitamin A substance, there must be a stimulating factor in cod liver oil similar to that in ultraviolet light, in addition to the vitamin A substance.

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7. Kestner: Ztschr. f. Biol. **73**:1, 1921; ibid., Beitr. z. klin. d. Tuberk **50**:121, 1922.

This is easily understood since Alfred F. Hess [8] and Steenbock, Nelson and Black [9] have shown by animal experiments that fats and other food materials, which are without effect on rickets, can be rendered active for experimental rickets merely by exposure to ultraviolet light. Eleanor Margaret Hume and Hannah Henderson Smith [10] (Lister Institute) have shown that exactly the same is the case with sawdust.

3. This proves that the nonspecific stimulating factor must be the ultraviolet rays.

4. Evidently the hypothetic antirachitic vitamin does not exist.

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8. Hess, A. F.: Experiments on the Action of Light in Relation to Rickets, Am. J. Dis. Child. **28**:517 (Oct.) 1924.

9. Steenbock, H.; Nelson, M. T., and Black, A.: J. Biol. Chem. **62**:275 (Nov.) 1924.

10. Hume, E. M., and Smith, H. H.: Biochem. J. **18**:1334, 1924.

THE CHEMICAL COMPOSITION OF THE SPINAL FLUID

DIAGNOSTIC VALUE *

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DIFFERENTIAL DIAGNOSIS

Differential diagnosis between the various forms of meningeal or central nervous system disease has not become simpler as our knowledge of the pathology and chemistry of these conditions has increased. While it is relatively easy to diagnose clinically the acute inflammatory or purulent types of disease from those of a less acutely inflammatory nature, the differentiation between the diseases comprising each group is still clinically and chemically confused. The clinical picture of epidemic, pneumococcal, influenzal or streptococci meningitis is, as a rule, distinct from that of epidemic encephalitis, anterior poliomyelitis, polioencephalitis or tuberculous meningitis.

Bacteriologically, the distinction in the former group is clearly enough defined. Chemically, the evidence is less definite in both groups. Differentiation between meningitis and meningismus, tetany and certain types of birth injuries at times may be very difficult. The determination of the primary lesion in instances of combined cardiorenal and meningeal conditions is often impossible, either clinically or with the aid of chemical investigation. A changed relation in the sugar concentration in blood and spinal fluid seemed at first to offer a differential point between poliomyelitis and encephalitis—two diseases often clinically confused.

It must be recognized that it is the level of the cerebrospinal axis involved, not the type of condition, that determines this changed relation between blood and spinal fluid sugar.

There is reason to believe that the permeability of the choroidal cells is affected in varying degree by different types of physical disturbance, and that they are not always equally permeable to all elements entering into the composition of the blood.

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* From the Department of Diseases of Children, College of Physicians and Surgeons, Columbia University. The Children's Medical Division and Department of Pathology, Bellevue Hospital.

Three conditions seem to be responsible for the chemical composition of the spinal fluid, whether the disease is of a metabolic or of an infectious nature, namely:

1. The chemical content of the blood, producing an effect on that of the spinal fluid through the permeability of the cells of the choroidal plexus; the so-called hemato-encephalic barrier.

2. Mechanical agents such as tumors of or hemorrhage into the spinal cord, producing congestion of the covering membranes.

3. Acute inflammatory bacterial or chemical conditions of the meninges, brain or cord.

Accurate interpretation of the relationship between blood and spinal fluid depends on definite knowledge of the chemistry of the fluids on either side of the barrier and on due consideration of the causes bringing about the changes noted. For example, a high percental relation between spinal fluid and blood sugar is expected in such conditions of the upper level of the neuron as epidemic encephalitis. This changed percental relation, however, is of true significance only when brought about by an absolute increase in sugar in the spinal fluid. A decrease in blood sugar would give the same disturbed relation but with less diagnostic significance.

This study was undertaken in the hope of gaining some information as to the variations in the general or selective permeability of the choroidal cells under the influence of disease. One hundred and five children furnish the material. They were suffering from a variety of diseases and clinically had one point in common, that is, sufficient evidence of meningeal irritation to warrant spinal tap.

There were twenty-three cases of miscellaneous central nervous system disease, negative as to evidence of inflammatory lesion, such as idiocies, birth injuries, quiescent hydrocephalus, epilepsy and chorea. There was a group of twenty-one, including meningismus, tetany, acidosis and nephritis. These again showed no evidences of acute inflammatory lesion, but the patients suffered from severe metabolic disturbance. There were twenty-one cases of poliomyelitis and epidemic encephalitis, primary conditions of the brain and spinal cord. There were sixteen cases of acute purulent meningitis, chronic basilar meningitis and syphilitic meningitis—acute infections of the meninges. There were twenty-four cases of tuberculous meningitis, a condition clinically and chemically quite distinct.

It was hoped that from such a study some definite diagnostic guide might be forthcoming. Without more definite knowledge of what disturbances of blood and spinal fluid chemistry are to be expected in such groups of cases, the importance of and necessity for such diagnostic procedures cannot be determined.

TABLE 1.—*Findings in Twenty-Three Cases of Miscellaneous Normals*

No.	Age	Sex*	Day Dis.	S. F. Char.	Press.	Cells	Diff.	Alb.	Glob.	Prot.	Ben.	% Blood Sugar	% Blood Sugar	Cl.	Ca.	Pros.	Acet.	Diagnosis and Comment
1	3½ yr.	♀	.....	Clear	N	5	..	0	1+	85	2+	59	59	702	5.2	1.9	—	Microcephaly
				Blood								100		573	9.5	5.9	—	
2	28 mo.	♀	.....	.....	..	10	..	0	1+	62.5	1+	64	54	725	5.3	1.6	—	Mongolian
				Blood								117		585	10	4.1	—	
3	2 yr.	♂	.....	Clear	..	<10	..	±	0	54	..	52	62	749	....	...	—	Microcephaly
				Blood								83		620				
4	1½ yr.	♂	.....	.....	..	10	..	..	..	62.5	..	56	59	749	....	...	..	Microcephaly
				Blood								95		597				
5	8 yr.	♂	.....	Clear	0	30	..	..	..	61	..	64	66	749	....	...	—	Idiocy
				Blood								96		612				
6	3½ yr.	♀	.....	Clear	1+	<10	..	0	0	81	1+	49	60	760	....	...	—	Idiocy
				Blood								82		585			—	
7	18 mo.	♀	.....	Clear	N	10	..	±	0	59.4	±	50	61	714	....	1.3	..	Amaurotic idiot
				Blood								81		582				
8	3 yr.	♀	.....	Clear	..	0	..	0	0	60	0	58	70	737	5.5	1.7	..	Cong. malf. brain, idiocy
				Blood								83		550	11.6	4.5		
9	.....	♀	.....	.....	..	10	..	1+	—	68	..	77	75	737	....	1.9	—	Birth injury
				Blood								102		585			—	
10	2¾ yr.	♀	.....	Clear	N	20	L	±	—	31	1+	48	52	737	....	...	..	Congen. syphilis, S. F.
				Blood								91		573				Wass. neg., bl. Wass. 4+
11	.....	♀	.....	Clear	±	13	..	1+	—	50	1+	80	88	702	....	1.7	..	Congen. syphilis, S. F.
				Blood								91		573				Wass. neg., bl. Wass. 4+
12	2½ yr.	♂	.....	Clear	1+	15	..	1+	0	29.8	1+	55	55	702	....	1.9	..	Polio (old)
				Blood								100		585		4		
13	11 yr.	♀	.....	Clear	N	10	..	0	0	33	..	69	64	714	....	1.6	..	Post. enceph. Park. syn.
				Blood								105		567				
14	10 yr.	♀	6½ wk.	Clear	1+	10	..	tr.	..	50	..	65	62	702	....	...	..	Hysteria
				Blood								105		527				
15	4 yr.	♀	1	Clear	..	10	..	..	..	57	..	100	64	760	....	...	..	Hysteria
				Blood								156		608				
16	9 yr.	♀	.....	.....	..	10	..	1+	—	33	..	61	55	714	....	1.6	—	Chorea
				Blood								111		573			—	
17	M	♂	.....	.....	..	10	..	..	..	75	..	53	45	737	....	1.8	—	Chorea
and				Blood								117		562			—	
18	.....	♀	.....	.....	..	8	..	1+	—	62.5	..	52	50	725	....	1.5	—	Corea
												105		573			—	
19	2¾ yr.	♀	1 yr.	Clear	1+	10	..	0	0	53	—	49	49	725	....	11.3	..	Ac. pul. and mil. tbc.
				Blood								100		562				
20	10 yr.	♂	15 mo.	Clear	1+	40	..	1+	1+	42	N	52	50	737	....	...	..	Epilepsy
				Blood								105		608				
21	8 mo.	♀	.....	Clear	—	20	..	±	—	60	—	57	53	725	....	1.7	..	Hydrocephalus
				Blood								108		573		5.7		
				Clear	2±	9	100 L	1+	0	62.5	±	50	37	702	4.7	...	..	
			Vent.	Clear	4+	4	100 L	±	0	53	1+	67	50	702	....	1.8	..	
				Blood								135		562	9.4	5.1		
22	9 mo.	..	.....	Clear	..	5	..	1+	1+	62	..	64	44	702	....	...	..	Hydrocephalus
				Blood								143		573				
23	2 yr.	♀	2 yr.	Clear	1+	..	..	1+	1+	62	1+	57	83	702	....	2	..	Hydrocephalus
				Blood								68		515		4.7		

* In this column, ♀ indicates female; ♂, male.

MISCELLANEOUS NORMALS

Group 1.—This consists of twenty-three cases of miscellaneous conditions affecting the central nervous system, noninflammatory in character, in which negative spinal fluid is to be expected.

The spinal fluid chlorids ranged from 690 to 760 mg. per hundred cubic centimeters, with an average of 723. These figures agree with those of most other workers. Mestrezat [1] gives 725 mg. as the normal range.

The blood chlorids averaged 576, the difference between blood and spinal fluid chlorids being 147. An occasionally high blood chlorid

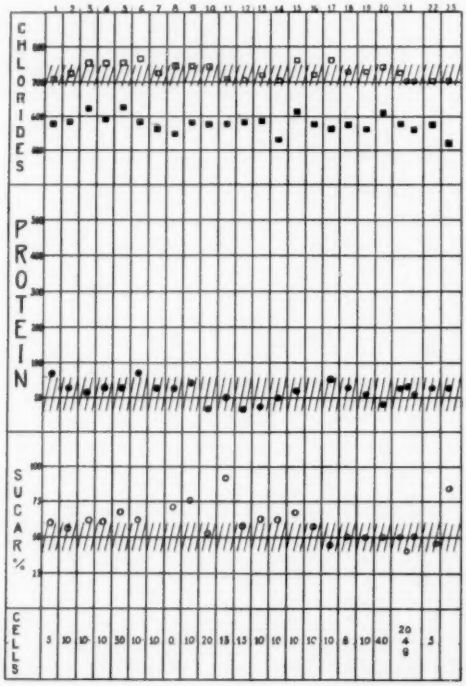

Chart 1.—Twenty-three cases of miscellaneous normals. In Charts 1 to 5 inclusive, spinal fluid chlorids are represented by open blocks and blood chlorids by solid blocks. Only the relative or percental values for sugar in the spinal fluid are given. The cross-hatching represents normal ranges. Chlorids and protein content are in milligrams per hundred cubic centimeters.

showed no corresponding increase in that of the spinal fluid. The same is true of two low blood chlorids, 525 and 515, showing no decrease. This lack of correspondence in blood and spinal fluid chlorids would seem to indicate that an estimation of the blood chlorids is of no clinical importance.

1. Mestrezat: Le Liquide Cephalo Rachidien, Paris, 1912.

Protein.—The protein range in this group was from 29.8 to 85 mg., with an average of 52 mg. This average and the upper normal limit is somewhat higher than that of Ayer and Foster [2] who used a different method. Their range in 48 normal subjects was from 16 to 38 mg., with an average of 25 mg. When a protein content of 80 mg. is obtained, a slight increase in qualitative reactions may be expected and conditions which warrant an expectation of increased protein usually obtain clinically. It is possible with refined methods that a somewhat lower figure may ultimately come to represent more truly the normal for protein.

Sugar.—The literature on the sugar content of the spinal fluid is voluminous and no attempt will be made to review it here. Most workers agree that there is a mutual relation between blood and spinal fluid sugar and that normally the spinal fluid sugar is from 40 to 60 per cent. of the blood sugar. Thalheimer and Updegraff [3] say that when the blood sugar increases the spinal fluid sugar increases, and that when there is a high blood sugar without an analogous increase in the spinal fluid sugar it is possible that a pathologic condition in the meninges and choroid plexus may hold back the glucose.

Goodwin and Shelley [4] conclude that there is a definite relationship between blood and spinal fluid sugar, and that the percental relation is fairly constant at from 45 to 65 per cent. They performed sugar tolerance tests on five subjects and found a small but definite rise in spinal fluid sugar in all. This occurs some time after the maximum rise in blood sugar. In one case the blood sugar rose from 105 to 110 mg. the first hour; 105 mg. the second hour and 90 mg. the fourth hour, the spinal fluid sugar going from 48 to 63 mg. in four hours. They further conclude that the spinal fluid sugar is not constant in the same person, and that there is no level within reasonable limits that might be considered normal for different individuals.

Parallel changes have been noted in diabetes and after the injection of epinephrin. Kasahara and Uetani [5] determined the spinal fluid sugar for a number of hours after the injection of insulin, and assumed that: "There is probably in the cerebrospinal fluid and blood always some parallelism of the content of the reducing substance and that, therefore, its concentration in the fluid varies directly with the degree of glycemia."

In this group, 20 per cent. of twenty-five taps gave a percental relation higher than 65; the remainder (or 80 per cent.) were within normal

2. Ayer, J. B., and Foster, H. E.: Quantitative Estimation of the Total Protein in the Cerebrospinal Fluid, J. A. M. A. **77**:365 (July 30) 1921.

3. Thalheimer, W., and Updegraff, H.: Sugar Content of Blood and Spinal Fluid in Encephalitis, Arch. Neurol. & Psychiat. **8**:15, (July 22) 1922.

4. Goodwin, G. M., and Shelley, H. J.: Sugar Content of Cerebrospinal Fluid and its Relation to Blood Sugar, Arch. Int. Med. **35**:242 (Feb.) 1925.

5. Kasahara, M., and Uetani, E.: J. Biol Chem. **59**:433 (March) 1925.

limits except in one case, which was normal actually but low relatively owing to a slightly high blood sugar. It is interesting to note that the ventricle fluid taken at the same time was 17 mg. higher than the spinal fluid and normal in relation to the blood. Of the five with high blood sugar, three were actually high with normal blood sugar, and two were high relatively having low blood sugar. There was nothing else abnormal in the fluids of these five cases. The high sugar showed no relation to other chemical findings.

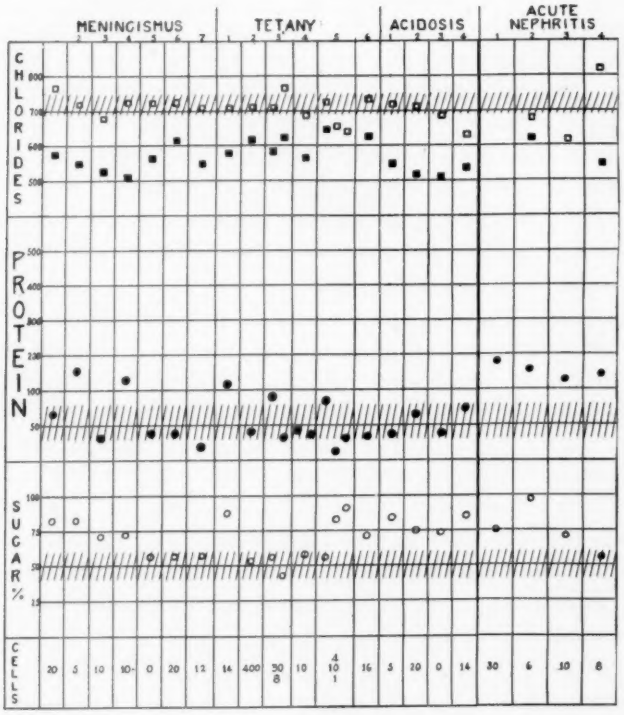

Chart 2.—Twenty-one cases of meningismus, tetany, acidosis and nephritis.

In the majority of normal cases the relation of spinal fluid sugar to blood is from 40 to 60 per cent. This relation is of no diagnostic value except when considered with reference to the actual content of spinal fluid and blood sugars, since a change in either will produce the same result.

SEVERE METABOLIC DISTURBANCE

Group 2.—There were seven cases of meningismus, accompanying pneumonia, otitis and general infections; six cases of tetany with convulsions; four cases of acidosis following gastro-enteritis, and four cases of nephritis following acute infections.

TABLE 2.—*Findings in Twenty-One Cases of Meningismus, Tetany, Acidosis and Nephritis*

No.	Age	Sex*	Day Dis.	S. F. Char.	Press.	Cells	Diff.	Alb.	Glob.	Prot.	Ben.	Sugar	% Blood Sugar	Cl.	Ca.	Pros.	Acet.	Diagnosis and Comment
1	6 mo.	..	.....	Clear	2+	20	..	1+	tr.	62.5	Red.	120	80	760	5.1	...	..	Meningismus, br. pneumonia
				Blood								150		579	8.9			
2	4½ yr.	♀	.....	Clear	Slight	5	..	—	1+	153	..	100	80	714	....	...	..	Meningismus, O. M. P. A.
				Blood								125		550				
3	.....	♂	.....	.....	....	..	..	..	..	31	..	85	70	679	...	2	..	Pn. meningismus, convulsions
				Blood								122		527		2.6		
4	8 yr.	♂	12	Clear	1+	<10	..	±	0	125	N	80	74	725	4	...	..	Meningismus, ac. rheumatic fever
				Blood								108		503	8.2			
5	7 mo.	♂	16	Clear	1+	0	..	Neg.	Neg.	37.2	..	75	60	725	6.3	1.44	..	Meningismus, lobar pneumonia
				Blood								125		562	12.1	3.1		
6	11½ mo.	♂	11½ mo.	Clear	0	20	..	Tr.	Neg.	37.2	±	68	59	725	....	1.65	..	Meningismus, O. M. P. A.
				Blood								115		608		5		
7	3 mo.	♂	5	Clear	1+	12	60 P	..	..	24.8	±	74	59	714	....	...	..	Meningismus, septicemia
				Blood								129		550				
8	5 yr.	♂	1	Clear	2+	14	..	±	0	105	1+	96	87	702	....	...	..	Convulsions
				Blood								110		585				
9	8 wk.	♂	15	Clear	1+	40	L	1+	0	40	1+	56	51	702	....	...	..	Tetany, convulsions, O. M. P. A.
				Blood								108		608	7	6.4		
10	8½ mo.	♀	3 mo.	.....	..	30	..	1+	—	93	..	54	56	702	5.4	1.7	2+	Tetany, convulsions
				Blood								95		585	6.4		2+	
						8	..	1+	—	31	..	54	44	760	....	1.6	..	
				Blood								122		620				
11	9 mo.	♂	.....	.....	..	..	..	..	..	47.5	..	79	64	600	5.6	1.9	..	Wh. cough, tetany
				Blood								116		502	5.1			
12	16 mo.	♂	3	Clear	1+	4	..	1+	1+	80	N	116	54	725	5.3	...	—	Tetany, convulsions
				Blood								215		644	7.2		—	
				Clear	1+	10	P	1+	—	14	N	94	82	655	5.2	...	..	Br. pneumonia
				Blood								114		640	6.8			
				Clear	—	1	L	—	—	32	1+	114	86	640	4.5	2	..	
				Blood								133		638	6.5	3.1		
13	6 mo.	♂	1 wk.	Clear	1+	16	14 L	1+	..	34.4	1+	55	72	737	....	...	—	Tetany, convulsions
				Blood								76		620	6.7	6.9	—	
14	6 mo.	♂	1½ wk.	Clear	1+	5	..	±	±	44	N	118	83	714	....	2.1	—	Acidosis
				Blood								142		550		4.35	—	
15	23 mo.	♂	.....	Clear	..	20	..	±	..	60	..	51	75	702	....	...	2+	Acidosis
				Blood								68		608			2+	
16	13 mo.	♀	.....	Clear	±	0	..	N	0	44	1+	73	73	690	....	...	..	Acidosis
				Blood								100		503		1.7		
17	14 mo.	♀	.....	Clear	—	14	..	1+	—	68	1+	87	79	632	....	...	2+	Acidosis
				Blood								110		538			2+	
18	4 wk.	♂	3½	Clear	1+	30	..	1+	1+	187	1+	50	75	...	....	...	..	Nephritis, septicemia
				Blood								66						
19	.....	..	.....	.....	..	8	..	..	..	131	..	81	55	807	....	...	..	Nephitis, convulsions
				Blood								147		550				
20	6 yr.	♂	.....	Clear	N	6	..	1+	1+	156	1+	52	96	687	....	...	..	Ac. nephritis
				Blood								54		625				
21	1 yr.	♂	.....	Clear	1+	10	..	1+	1+	125	2+	90	71	610	....	...	..	Ac. nephritis
				Blood								126		600				

* In this column, ♀ indicates female; ♂, male.

TABLE 3.—*Findings in Twenty-One Cases of Poliomyelitis and Encephalitis*

No.	Age	Sex*	Day Dis.	S. F. Char.	Press.	Cells	Diff.	Alb.	Glob.	Prot.	Ben.	% Blood Sugar		Cl.	Ca.	Pros.	Acet.	Diagnosis and Comment
												Sugar	Sugar					
1	3 yr.	♀	1½ da.	Clear	1+	15	L	1+	1+	43	1+	70	93	702	....	...	..	Poliomyelitis
				Blood								75		600				
2	9 yr.	♀	3	Opaque	2+	1800	90 L	2+	2+	94	±	48	43	715	....	...	..	Poliomyelitis, abortive
				Blood								111		538				
			10	Clear	1+	60	80 L	±	±	49	1+	62	60	702	....	1.6	..	
				Blood								102		562		4.9		
3	22 mo.	♀	1	Clear	1+	250	100 L	2+	2+	56	..	69	..	690	....	...	..	Poliomyelitis
			3	Clear	..	50	100 L	1+	±	62.5		70		667	4.4	2		
4	3½ yr.	♂	5	Dirty	1+	180	100 L	1+	2+	250	±	56	..	702	....	...	..	Poliomyelitis
			6	Clear	1+	70	..	1+	1+	146	±	45	70	702	....	2.1	..	
				Blood								64		567		4.8		
			11	Clear	1+	4	..	—	—	200	—	49	..	679	....	1.8	..	
			18	Clear	..	12	..	2+	2+	125	1+	85	83	690	....	2	..	
				Blood								102		550		4.8		
5	9 mo.	♂	6	Clear	1+	55	L	2+	±	60	1+	50	48	743	....	...	..	
				Blood								103		562				
6	2½ yr.	♂	6	Clear	1+	320	75 L	±	0	40	..	90	73	737	....	...	..	
				Blood								123		550				
1	20 mo.	♂	2	Clear	1+	210	L	2+	±	47	2+	70	87	714	....	...	—	Encephalitis
				Blood								80		585			1+	
			4	Clear	N	75	90 L	±	—	74	..	66	69	714	....	1.9	—	
				Blood								95		585		5.1	—	
2	5 yr.	♂	2	Clear	1+	20	..	1+	tr.	42	N	70	80	725	....	...	..	Encephalitis
				Blood								87		527	10.5	4.0		
3	5 yr.	♀	2	Clear	2+	7	..	2+	1+	144.4	1+	53	45	737	....	...	2+	Encephalitis
				Blood								115		573		4.5	2+	
			4	Clear	Decr.	..	..	..	..	150	..	60	50	...	....	...	..	
				Blood								120						
4	2¾ yr.	♂	3	Clear	2+	120	100 L	1+	1+	47	1+ ±	70	63	715	....	...	2+	Encephalitis
				Blood								111		562			3+	
			5	Clear	1+	130	100 L	1+	1+	62.5	1+	49	54	737	....	2	2+	
				Blood								91		597	10.7	6.3	3+	
			9	Clear	±	20	90 L	1±	1±	62.5	1+	57	84	737	....	...	..	
				Blood								68		538				
			22	Clear	1	10	..	±	±	50	1+	56	70	749	4	1.6	..	
				Blood								80		585	11	4.5		

5	4 yr.	♀	3	Clear	1+	11	..	1+	2+	134	1+	66	60	...	....	...	..	Encephalitis
				Blood								110						
			4	Clear	2+	19	..	1+	2+	121	1+	100	92	...	....	...	..	
				Blood								118						
6	8 yr.	♂	5	Clear	2+	0	..	0	0	134	1+	69	..	702	....	...	..	Encephalitis
			22	Clear	1+	10	..	0	0	104	1+	61	61	749	....	4.9	..	
				Blood								100		585		9.7		
7	7 yr.	♀	5	Clear	2+	10	..	1+	±	90	1+	83	75	702	....	...	1+	Encephalitis
				Blood								111		575			1+	
8	5 yr.	♂	5	Clear	1+	70	100 L	1+	1+	117	1+	39	65	700	....	...	..	Encephalitis
				Blood								60		606				
9	10 yr.	♂	7	Clear	2+	15	..	2+	2+	248	3+	80	73	784	....	1.5	—	Encephalitis
				Blood								110		583			—	
			17	Clear	2+	4	L	1+	tr.	25	N	62	71	725	....	...	—	
				Blood								87		538				
10	4 yr.	♂	10	Clear	2+	340	L	..	..	148	..	72	60	...	....	1.6	2+	Encephalitis
				Blood								120		573		3.1	2+	
			13	.....	..	..	..	..	..	150	..	70	61	644	....	2.4	..	
				Blood								114		620		3.2		
11	6 yr.	♀	11	Clear	1+	0	..	1+	0	72	1+	80	56	...	5.9	1.6	..	Encephalitis
				Blood								142			11	4.4		
			13	Clear	0	185	65 L	2+	0	..	..	30	..	....	....	...	..	
			26	Clear	1+	98	95 L	0	0	93	1+	64	58	737	....	...	..	
				Blood								111		596				
				Clear	2+	28	L	1+	0	71	1+	52	..	725	....	...	..	
12	5 yr.	♂	11	Clear	4+	100	90 L	2+	±	94	2+	77	71	714	....	...	—	Encephalitis
				Blood								109		597			—	
13	6 yr.	♀	15	Clear	2+	10	..	1+	±	93	1+	64	70	737	....	...	..	Encephalitis
				Blood								91		585				
14	16 mo.	♂	..	Clear	±	0	..	1+	0	63	1+	40	62	725	....	...	3+	Encephalitis
				Blood								65		585			3+	
				Clear	1+	0	..	1+	0	47	..	75	86	725	....	...	3+	
				Blood								87		590			3+	
				Clear	±	0	..	±	0	47	..	98	103	655	....	...	1+	
				Blood								95					1+	
15	4½ yr.	♀	2	Clear	1+	20	..	1+	tr.	42	N	70	56	725	....	...	..	
				Blood								125		550				

* In this column, ♀ indicates female; ♂, male.

Chlorids.—The changes were irregular and not characteristic. In three patients with nephritis two were low with high normal blood chlorids. One was high (807) with normal blood chlorids (550). Csaki, quoted by Steiner and Beck,[6] and others, find increased values in nephritis.

Protein.—High protein is occasionally reported in meningismus. This is borne out by two of the cases in this group. In tetany, three out

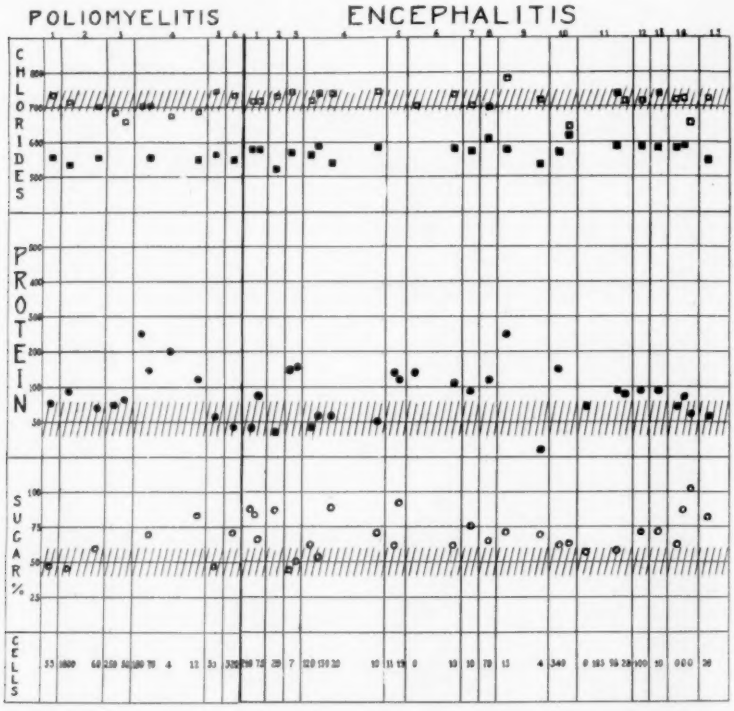

Chart 3.—Twenty-one cases of poliomyelitis and encephalitis.

of ten taps showed an increase. The acidosis cases were normal as to protein. All four patients with nephritis showed a marked increase.

Sugar.—Fifty-seven per cent. of the meningismus cases showed high sugar content relatively and absolutely. The average for the blood was 126; for the spinal fluid, 96 mg. There was no constant relation between sugar and the other elements. Only two cases showed both high sugar and protein. Forty-four per cent. of tetany, 100 per cent. of acidosis cases and 75 per cent. of nephritis cases showed relative increase in sugar.

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6. Steiner, B., and Beck, R.: Diagnostic Significance of Chlorids in Spinal Fluid, Jahrb. f. Kinderh. **103**:223 (Nov.) 1923.

POLIOMYELITIS AND ENCEPHALITIS

Group 3.—These two conditions are grouped because of their clinical similarity and the consequent difficulty in differential diagnosis. The chlorids are low in 36 per cent. of the spinal fluid of the poliomyelitis cases, as opposed to 8 per cent. in encephalitis. In both groups only one case showed high chlorids, 784 mg., with an accompanying high protein and sugar. In neither case was there any corresponding change in the blood chlorids.

In poliomyelitis the protein was high in 45 per cent., averaging 86 mg. The range was from 42 to 250 mg. In encephalitis the protein range was between 42 and 248 mg., tending to fall with clinical improvement. The average protein in twenty-four taps during the acute stage was 100.4 mg.

Sugar.—Corresponding to the belief that spinal fluid sugar varies directly with the cord level involved, the figures for these two diseases show normal concentration in poliomyelitis and high in encephalitis. The high sugar in Case 4 (poliomyelitis) is more apparent than real, as the early high figure depends on a low blood sugar and the late one on a complicating pneumonia for its causation. Case 6 does not offer an actual exception to the expected rule in that it was complicated by a high spinal cord lesion.

In encephalitis the range of sugar concentration was consistently high—81 per cent. was relatively high, 60 per cent. was actually so. The average blood sugar was 99 mg., failing to show the hyperglycemia claimed by some to occur in this disease.

The spinal fluid sugar average was 65 mg. There was no direct relationship between the sugar and clinical, chemical or cellular findings.

The cells followed the expectation, being higher in poliomyelitis (from 55 to 1,800) than in encephalitis (from 0 to 340).

ACUTE PURULENT, CHRONIC AND SYPHILITIC MENINGITIS

Group 4.—As is to be expected in acute inflammatory conditions, the spinal fluid chlorids were found definitely low in purulent meningitis. In the case of chronic and syphilitic meningitis the range was normal, with a tendency to reduction. Protein was consistently high in the acute purulent group in the early taps before the use of serum, ranging from 172 to 1,798, with an average of 416.7 mg. In the chronic and syphilitic group there was a moderate but definite increase.

Corresponding to the expectation in acute inflammatory processes, the sugar was both absolutely and relatively reduced in the purulent group, with a few normal readings occurring early in the disease. Low chlorids and sugar are generally found in purulent meningitis. It is to be noted that three of these patients showed a normal sugar on early

TABLE 4.—*Findings in Thirteen Cases of Chronic, Purulent and Syphilitic Meningitis*

No.	Age	Sex*	Day Dis.	S. F. Char.	Press.	Cells	Diff.	Alb.	Glob.	Prot.	Ben.	Sugar	% Blood Sugar	Cl.	Ca.	Pros.	Acet.	Diagnosis and Comment
1	3 yr.	♂	..	Clear	1+	..	..	1+	1+	212	..	72	72	708	....	...	2+	Chr. meningitis, hydrocephalus
				Blood								100		573			2+	
2	22 mo.	..	..	Clear	1+	20	100 L	0	0	124	1+	57	54	720	....	...	..	Chr. basilar meningitis
				Blood								105		573				
3	9 mo.	♀	5 mo.	Clear	2+	60	80 L	1+	1+	110	1+	50	53	...	....	...	..	Chr. meningitis, hydrocephalus
				Clear	1+	8	..	±	±	88	1+	53	53	...	....	...	..	
				Blood								100		548				
			Vent.	Opal.	4+	100	50 L	2+	±	134	±	55	55	690	....	...	..	
1	11 wk.	♀	2	Cloudy	..	1700	85 P	4+	4+	348	..	5	4	644	....	...	..	Strep. meningitis
				Blood								110		547				
2	11½ yr.	♂	7	Opal.	2+	930	71 P	3+	3+	192	—	91	68	725	....	...	3+	Strep. meningitis
				Blood								133		562			3+	
			8	Turbid	2+	4800	90 P	4+	3+	401	1+	73	87	702	....	...	1+	
				Blood								160					1+	
			9	Opal.	2+	740	80 P	4+	2+	458	1+	5	3	702	....	2.25	4+	
				Blood								160		585			2+	
3	7 mo.	♀	6	Cloudy	2+	2240	76 P	..	1+	306	..	14	16	697	....	...	..	Flu., meningitis
				Blood								83		608				
			6	Cloudy	2+	..	..	..	..	438	..	19	..	644	....	...	..	
			7	Cloudy	2+	Innum.	..	3+	2+	449	..	17	..	725	....	...	..	
4	6 yr.	♂	10 hr.	Cloudy	2+	6000	70 P	2+	3+	225	2+	83	50	702	....	...	..	Pn. meningitis
				Blood								166		538				
			2	Cloudy	1+	4000	94 P	2+	3+	381	1+	5	3	667	....	...	..	
				Blood								150						
			3	Cloudy	1+	5000	..	2+	3+	625	..	5	3	667	....	...	..	
				Blood								130						
5	9 yr.	♂	2	Cloudy	2+	500	50 P	2+	2+	234	0	± 0	0	644	....	...	..	Pn. meningitis
					1+	7000	..	4+	4+	1281	0	±	0	608				
6	14 mo.	♂	14	Cloudy	..	280	85 P	2+	2+	375	..	10	8	673	....	...	..	Pn. meningitis
				Blood								125		573				

7	5 mo.	♂	4	Cloudy	1+	4000	95 P	2+	3+	1798	±	17	8	655	....	...	..	Pn. meningitis
				Blood								191		562				
8	4 yr.	♀	5	Opal.	4+	1700	100 P	4+	4+	338	1+	19	15	644	....	...	..	Pn. meningitis
				Blood								125		585				
				Cloudy	1+	1260	80 P	3+	4+	391	1+	12	..	632	....	...	..	
9	10 mo.	♀	9	Cloudy	..	2000	..	..	..	179	..	5	..	644	....	...	..	Pn. meningitis
				Blood								100		538				
10	11 mo.	♀	2	Cloudy	2+	1000	80 P	2+	2+	172	1+	57	63	644	....	...	..	
				Blood								90		690				
			3	Cloudy	—	1300	70 L	2+	2+	106	1+	31	38	690	....	...	..	
				Blood								80		585				
			4	Cloudy	1+	..	..	2+	1+	62.5	1+	36	..	690	....	...	..	
			4	Cloudy	1+	1250	..	2+	1+	206	—	37	..	667	....	...	..	
			5	Cloudy	1+	..	98 P	2+	1+	62.5	—	50	..	690	....	...	..	
			6	Cloudy	±	800	90 L	2+	1+	588	1+	57	..	725	....	...	..	
			7	Cloudy	1+	900	97 L	2+	1+	562	2+	42	..	702	....	...	..	
			9	Cloudy	±	180	98 L	1+	±	188	2+	50	..	679	....	...	..	
			15	Clear	±	20	98 L	1+	—	725	1+	48	..	702	....	2.1	..	
			23	Clear	±	4	100 L	1+	1+	58	1+	60	..	644	....	2.1	..	
1	9 yr.	♂	.....	.....	N	210	88 L	1+	2+	..	1+	31	32	...	....	...	..	Syphilitic meningitis, cong. syphilis, S. F. and blood Wass. 4+
				Blood								95						
					N	340	..	..	2+	..	1+	32	33	...	....	...	..	
				Blood								97						
					N	..	..	..	2+	..	1+	26	29	...	....	...	..	
												95						
2	11 yr.	♀	.....	Clear	..	70	..	1+	2+	93	..	44	52	702	4	2.3	..	Syphilitic meningitis, cong. syphilis
				Blood								84		562	10.3	5.1		
3	5 mo.	♂	4	Clear	1+	300	60 L	2+	1+	113	N	100	70	737	....	...	..	Syphilitic meningitis, cong. syphilis, S. F. and blood Wass. 4+
				Blood								143		608	7.2			
				Sl. Op.	2+	270	95 L	2+	2+	125	2+	76	49	690	....	2.2	..	
				Blood								157		644				
				Clear	1+	120	80 L	2+	1+	53	Red.	57	48	714	....	2.1	..	
				Blood								118		585				
				Clear	2+	220	88 L	2+	tr.	77.7	Red.	64	49	737	....	1.85	..	
				Blood								129		620				
				Clear	..	30	..	..	..	62.5	..	20	39	679	....	0	..	
				Blood								102		562				

* In this column, ♀ indicates female; ♂, male.

taps. In these there was a reduction of sugar to the expected or characteristic level in later taps. A corresponding reduction in chlorids occurred in two of these three.

In the syphilitic group the tendency seemed to be toward reduction in sugar content. Kelley [7] believes that sugar is decreased in untreated cases of syphilis of the central nervous system and returns to normal with treatment. This has been corroborated by other workers. Case 1 agrees with these findings, but Cases 2 and 3 show that such is not

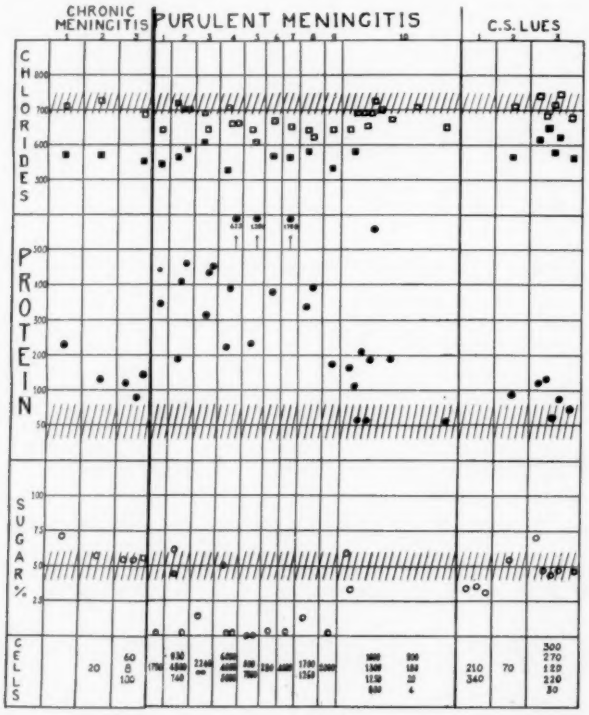

Chart 4.—Thirteen cases of chronic, purulent and syphilitic meningitis.

always the finding. In chronic meningitis one case showed a relative and actual high sugar. The other figures all were normal.

TWENTY-FOUR CASES OF TUBERCULOUS MENINGITIS

Group 5.—These cases are arranged so far as is possible with relation to the day of disease. The most consistent chemical findings occur in this group. In every case the spinal fluid chlorids were definitely low. The blood chlorids were reduced, but to a less extent. The average spinal fluid chlorid was 637 mg., the average blood was 538, giving an

7. Kelley, A. G.: South. M. J. **16**:407 (June) 1923.

average difference of 99 mg. as opposed to the normal difference of about 150. The protein ranged consistently high. There was apparently no relation between it and the estimated day of the disease on which the examination was made.

In twenty-four cases, with first taps done on the first to the twenty-first day after onset, the protein ranged from 104 to 370 mg. The average for such first taps was 203.6 mg. The protein in cases tapped late in the disease seemed to be no higher than in those cases tapped early. The highest figure, 370 mg., was obtained in a patient tapped five days after onset.

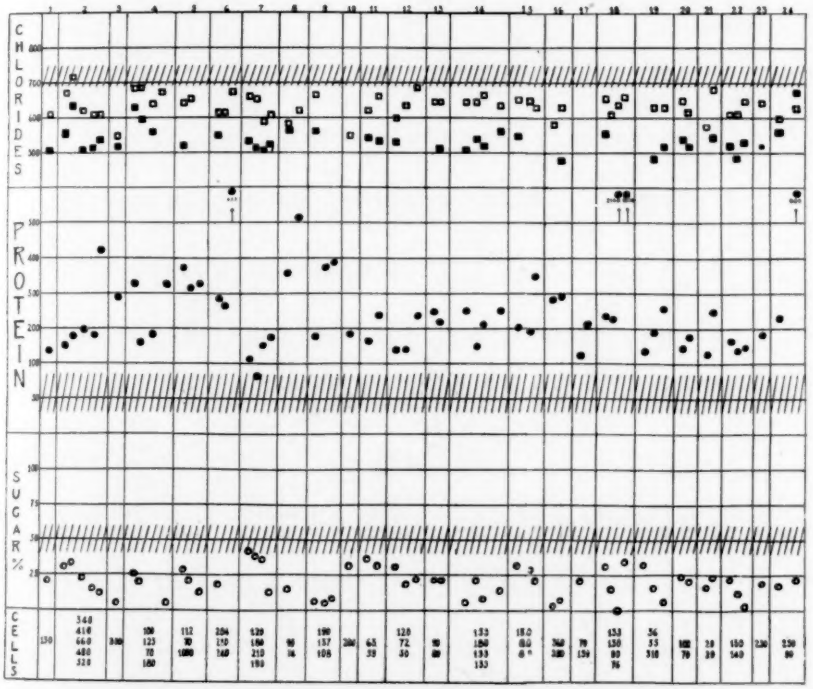

Chart 5.—Twenty-four cases of tuberculous meningitis.

Of twenty taps, done the second time, the range was from 80 to 880 with an average of 256.2 mg., a slight increase over the average of the first taps, 203.6 mg. Ten of these, or 50 per cent., showed an increased protein, nine, or 45 per cent., showed a decreased amount of protein, one gave the same figure as on the first tap.

In eighteen, the third, fourth and fifth taps ranged from 136 to 2,140 mg., with an average of 419 mg. Twelve, or 66 per cent., showed an increase over the first tap, four, or 22 per cent., showed a decrease, and two cases showed no change.

TABLE 5.—*Findings in Twenty-Four Cases of Tuberculous Meningitis*

No.	Age	Sex*	Day Dis.	S. F. Char.	Press.	Cells	Diff.	Alb.	Glob.	Prot.	Ben.	Sugar	% Blood Sugar	Cl.	Ca.	Pros.	Acet.	Diagnosis and Comment
1	2 yr.	♂	1	Clear	±	130	71 L	2+	2+	136	..	25	23	608	....	...	1+	Tb. meningitis
				Blood								105		503			1+	
2	11 mo.	♂	2	Clear	2+	340	86 L	1+	2+	148	—	44	27	667	....	2	—	Tb. meningitis
				Blood								161		560		3.4	—	
			4	Clear	1+	410	85 L	2+	3+	174	—	32	28	714	....	2.1	—	
				Blood								114		632		3.4	—	
			7	Cloudy	..	660	..	2+	4+	198	—	34	24	620	....	...	..	
				Blood								140		503				
			10	Clear	..	480	79 L	2+	2+	186	—	21	16	608	....	2	..	
				Blood								125		515		3.6		
			12	Clear	N	520	..	2+	2+	415	—	15	14	608	....	2	..	
				Blood								108		538		3.7		
3	7 yr.	♂	3	Clear	2+	300	100 L	3+	3+	294	0	5	5	549	....	...	..	Tb. meningitis
				Blood								97		520				
4	10 mo.	♀	5	Clear	1+	100	..	2+	2+	322	Red.	37	25	600	....	...	2+	Tb. meningitis
				Blood								148		632			2+	
			6	Clear	2+	125	92 L	2+	2+	161	±	30	19	600	....	1.6	..	
				Blood								159		607				
			9	Clear	1+	70	82 L	1+	1+	188	—	30	27	644	....	1.7	..	
				Blood								110		562				
			11	Clear	N	180	L	2+	2+	322	—	5	5	679	....	1.3	..	
				Blood								85						
5	4½ yr.	♂	5	Clear	±	112	75 P	2+	2+	370	±	31	26	643	5.3	...	..	Tb. meningitis
				Blood								114		526	10.6			
			7	Clear	2+	70	100 L	2+	1+	306	±	28	22	655	....	...	..	
				Blood								125						
			10	Clear	1+	1000	100 L	2+	1+	320	0	20	14	...	....	...	..	
				Blood								142						
6	5½ mo.	♂	6	Clear	3+	204	..	1+	2+	295	±	23	17	613	....	...	..	Tb. meningitis
				Blood								137		550				
			7	Clear	3+	210	..	3+	2+	267	0	19	..	613	....	...	..	
			9	Clear	2+	240	..	4+	2+	625	0	22	..	675	....	...	..	
7	8½ yr.	♂	7	Clear	2+	120	L	2+	1+	104.5	Red.	44	40	667	....	...	..	Tb. meningitis
				Blood								110		538				
			9	Clear	2+	180	62 L	2+	1+	80	1+	40	36	655	....	1.9	..	
				Blood								110		515		3.7		
			11	Clear	2+	210	75 L	2+	1+	149	1+	36	32	597	....	...	—	
				Blood								110		503			—	
			13	Clear	2+	190	78 L	3+	1+	178	—	20	14	608	....	2.1	—	
				Blood								140		527			—	

8	9 mo.	♂	7	Clear	2+	90	100 L	2+	3+	351	0	15	15	587	....	...	..	Tb. meningitis
				Blood								100		572				
			10	Clear	1+	74	L	3+	3+	504	..	26	..	625	....	...	..	
9	6 mo.	♀	8	Clear	1+	190	100 L	1+	1+	173	0	10	10	662	....	...	..	Tb. meningitis
				Blood								100		502				
			11	Clear	2+	137	100 L	2+	3+	377	0	10	8	...	....	...	..	
				Blood								122						
			13	Clear	1+	108	100 L	2+	2+	388	0	18	13	...	....	...	..	
				Blood								135						
10	7½ mo.	♂	8	.....	2+	200	..	..	..	190	..	45	30	550	....	2.17	..	Tb. meningitis
				Blood								155				3.33		
11	4 yr.	♀	10	Clear	1+	63	..	2+	1+	168	1+	45	37	625	....	...	..	Tb. meningitis
				Blood								123		543				
			13	Clear	1+	59	..	3+	2+	235	1+	35	27	662	....	...	..	
				Blood								130		537				
12	7 yr.	♀	10	Clear	3+	120	100 L	1+	1+	130	±	30	26	600	....	...	..	Tb. meningitis
				Blood						114		114		537				
			13	Clear	3+	72	100 L	2+	1+	130	0	22	17	637	....	...	..	
				Blood								124						
			16	Clear	3+	50	100 L	2+	2+	230	0	35	21	687	....	...	..	
				Blood								166						
13	22 mo.	♀	10	Clear	2+	90	100 L	4+	2+	248	±	23	20	643	....	...	..	Tb. meningitis
				Blood								112						
			11	Clear	2+	80	100 L	4+	2+	210	0	30	20	643	5.8	...	2+	
				Blood								125		513	10.9		2+	
14	5½ yr.	♂	10	Clear	0	155	76 L	2+	2+	248	..	5	4	644	....	...	..	Tb. meningitis
				Blood								105		503				
			13	Clear	1+	180	80 L	2+	2+	148	..	25	20	644	....	2.05	2+	
				Blood								122		538	12.4	3.08	1+	
			15	Clear	0	155	80 L	..	..	210	..	15	12	662	....	2.2	3+	
				Blood								121		515		3.4	3+	
			20	Clear	2+	155	82 L	2+	2+	248	..	21	15	635	6.3	2.7	..	
				Blood								133		503	12.1	3.32		
15	2 yr.	♀	13	Clear	2+	130	100 L	1+	1+	200	±	38	30	650	....	...	..	Tb. meningitis
				Blood								125		550				
			16	Clear	2+	80	100 L	2+	1+	190	±	40	27	650	....	...	..	
				Blood								145						
			18	Clear	11+	80	100 L	2+	1+	342	±	36	22	637	....	...	..	
				Blood								160						
16	14 mo.	♀	14	Dirty	2+	360	95 L	2+	1+	279	0	10	7	585	....	...	..	Tb. meningitis
				Blood								145						
			15	Clear	2+	280	..	2+	1+	294	0	10	8.3	635	....	...	..	Tb. meningitis
				Blood								120		479				

* In this column, ♀ indicates female; ♂, male.

TABLE 5.—*Findings in Twenty-Four Cases of Tuberculous Meningitis—Continued*

No.	Age	Sex*	Day Dis.	S. F. Char.	Press.	Cells	Diff.	Alb.	Glob.	Prot.	Ben.	Sugar	% Blood Sugar	Cl.	Ca.	Pros.	Acet.	Diagnosis and Comment
17	4½ yr.	♂	14	Clear	2+	70	100 L	2+	1+	117	0	20	22	...	....	...	..	Tb. meningitis
				Blood								89						
			16	Clear	1+	159	100 L	3+	2+	206	0	40	..	...	....	...	..	
18	11 mo.	♀	14	Clear	3+	133	100 L	1+	2+	231	1+	39	30	662	....	...	..	Tb. meningitis
				Blood								129		562				
			15	Clear	1+	130	100 L	1+	2+	228	±	24	16	602	....	...	..	
				Blood								142						
			16	Clear	1+	90	100 L	1+	2+	2140	0	0	0	637	....	...	..	
												155						
			16	Vent. Clear	..	76	100 L	1+	2+	1020	1+	57	36	667	....	...	..	
19	9 yr.	♀	14	Clear	1+	36	95 L	2+	1+	130	..	30	26	...	....	...	..	Tb. meningitis
				Blood								116			8.4	2.45	..	
			17	Clear	1+	55	85 L	2+	±	190	..	20	16	630	....	2	..	
				Blood								120		480		3		
			20	Clear	N	310	..	2+	2+	250	..	10	7	630	5.8	3.1	..	
				Blood								130		508	8.9	3.8		
20	3 yr.	♀	14	Clear	2+	100	L	2+	2+	139	1+	31	24	655	....	...	..	Tb. meningitis
				Blood								125		538				
			15	Clear	2+	70	86 L	1+	2+	168	1+	27	20	620	....	2.85	..	
				Blood								133		515		3.45		
21	6 yr.	♂	14	Clear	1+	20	100 L	—	1+	124	3+	15	15	573	....	...	..	Tb. meningitis
				Blood								100						
			16	Clear	1+	20	100 L	2+	2+	248	±	40	24	678	....	...	..	
				Blood								162		538				
22	5 yr.	♀	16	Clear	2+	150	L	0	1+	162	Sl. Red.	30	22	608	....	1.43	..	Tb. meningitis
				Blood								133		515		1.8		
			18	Clear	1+	140	L	1+	1+	134	0	15	12	608	....	2.1	..	
				Blood								120		480				
			20	Clear	2+	..	..	..	..	136	..	5	4	644	....	2.7	2+	
				Blood								104		527			2+	
23	3 yr.	♀	16	Dirty	2+	250	..	2+	2+	188	—	30	18	640	....	...	..	Tb. meningitis
				Blood								166		514				
24	11 yr.	♀	21	Clear	2+	250	100 L	2+	2+	210	0	24	16	600	....	...	..	Tb. meningitis
				Blood								150		569				
			26	Dirty	2+	90	100 L	2+	2+	880	0	38	20	625	....	...	..	
				Blood								182		675				

* In this column, ♀ indicates female; ♂, male.

It thus seems that while there is usually a progressive increase in protein in tuberculous meningitis, it is not a constant early finding but is more constant later. The curve rises less abruptly during the early half of the disease.

The sugar findings in this group are characteristic and are the most consistent of any of the groups. They are all relatively low; the majority are actually low.

On twenty-four first taps, the range was from 5 to 45 mg., with an average of 27 mg.; 4, or 16.6 per cent., fell within the normal actual range and these were low normals—44, 44, 45, 45 mg. A high or normal blood sugar, which seems to be the rule in tuberculous meningitis, made the low relative value. The blood sugar at first tap ranged from 89 to 166 mg., with an average of 126 mg.

The percental range on the first tap was from 4 to 40 per cent., with an average of 21 per cent.

Of thirty-seven later taps on the twenty-four cases, 10, or 26 per cent., showed a slight increase in sugar over the first taps. Four, or 10 per cent., showed no change and the remainder, or 64 per cent., were lower than the first tap. Three, or 0.8 per cent., were in the normal range, 40 mg. in each case. The actual range was from 0 to 40 mg., with an average of 23 mg. slightly lower than on the first tap.

On the later taps the percental relation was much lower. The range was from 0 to 30 per cent. and the average was 17 per cent. Twenty-one per cent. of these later taps showed an increased percental relation over the first tap, but none of these went to normal.

Calcium.—Calcium determinations (Chart 6) were made on the blood and spinal fluid of eighteen children, among whom were five with tetany. In those without tetany, the blood calcium ranged from 8.9 to 12.1 mg. per hundred cubic centimeters, an average of 10.5. The spinal fluid calcium ranged from 4 to 6.3 mg., an average of 5.2 mg. Normally, then, the spinal fluid calcium is about 50 per cent. of that of the blood. In tetany the blood calcium ranged from 5.1 to 8.7 mg., averaging 6.9; the spinal fluid calcium ranged from 4 to 5.6 mg. and averaged 4.9 mg., a slightly lower average than the normal.

Critchley and O'Flynn [8] find the normal spinal fluid calcium to be 6.2 mg. In tetany they find a marked fall in the acute phase and a rapid increase in convalescence. As will be seen from the chart, the five cases for which we have figures do not show this. The calcium content of the spinal fluid is quite constant and is independent of the blood calcium or the clinical condition and therefore seems to have no diagnostic value.

8. Critchley, M., and O'Flynn, E.: Brain **47**:337 (Aug.) 1924.

Phosphorus.—Determinations of inorganic phosphorus (Chart 7) in the spinal fluid of thirty-five miscellaneous cases, including poliomyelitis and encephalitis, showed a range of 1.2 to 2.1 mg. per hundred cubic centimeters, with an average of 1.7 mg. Blood phosphorus determinations were done on twenty of these cases. From these figures it will be seen that, as was the case with calcium, the phosphorus content of the spinal fluid is independent of the blood content.

An increase in spinal fluid phosphorus was noted in acute and tuberculous meningitis. Twenty-eight determinations on these cases showed

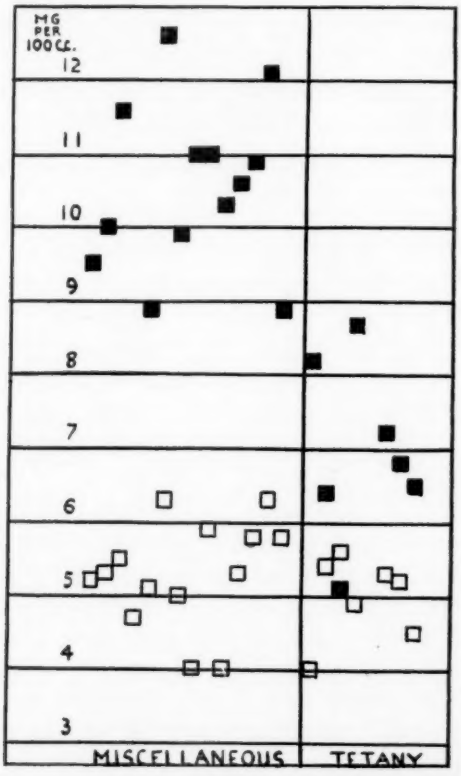

Chart 6.—Blood and spinal fluid calcium. The blood calcium is represented by solid blocks; the spinal fluid calcium by open blocks.

a range of from 1.4 to 3.1 mg., of which seventeen, or 60 per cent., were 2.1 mg., or higher. In tuberculous meningitis there seems to be a progressive increase in spinal fluid phosphorus. First taps frequently gave normal figures; later taps showed a definite increase.

Cohen [9] gives 1.64 mg. as the average in forty-one normal cases. He also finds an increase in acute and tuberculous meningitis. He con-

9. Cohen, H.: Quart. J. Med. **17**:289 (April) 1924.

cludes that the high phosphorus in tuberculous meningitis is an important point in differentiating this condition from encephalitis. In our series a high phosphorus was not found regularly on the first taps.

Since it is in the early stages that the diagnosis is most often in doubt, it does not seem that the determination of spinal fluid phosphorus has much diagnostic importance.

Acetone.—Qualitative tests for acetone in blood and spinal fluid were carried out in forty-two cases.

Method: 1 c.c. of blood plasma or spinal fluid was shaken with 1 to 2 gm. of ammonium sulphate. A few drops of freshly prepared solution of sodium nitroprusside were added and then a layer of ammonium hydroxid. The formation of a purple ring indicated the presence of acetone.

Nine tests were made in the normal group (No. 1) all of which were negative. In the metabolic group (No. 2) there were three negative and

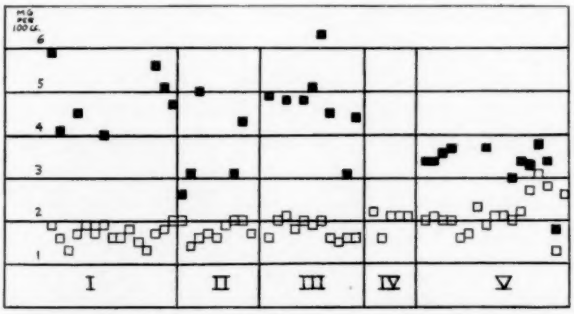

Chart 7.—Blood and spinal fluid phosphorus. Blood phosphorus is represented by solid blocks; spinal fluid phosphorus by open blocks. The numerals at the bottom of each division indicate the groups from which the cases were taken.

three positive reactions. In encephalitis cases, five were negative and eight positive and in purulent meningitis four were positive. In tuberculous meningitis four were negative and six were positive.

So far as could be determined from qualitative tests, acetone was present in approximately the same amounts in blood and spinal fluid as was to be expected with so readily diffusable a substance.

Nothing can be said of the effect of the presence of acetone in the subarachnoid space on the central nervous system. It undoubtedly causes a change in hydrogen ion concentration in the spinal fluid. Peterson, Haines and Webster [10] state that acetone has not shown itself to be toxic. It is possible to have a severe acetonemia in diabetes without coma.

10. Peterson, Haines and Webster: Legal Med. & Toxicology, Ed. 2, **2**.

Genôese [11] concludes that acetone does not pass into the spinal fluid when the meningeal permeability is normal. He has noted intense acetonuria with no acetone in the spinal fluid. It is, however, always present in the spinal fluid of meningeal infection. Its presence in toxic states must be considered as an indication of a breakdown in the function of the choroid plexus, brought about by toxins or endogenous poisons.

As noted in the foregoing, whenever an acetonemia was present there was acetone in the spinal fluid. It is difficult to understand an intense acetonuria and therefore acetonemia without acetone in the spinal fluid, and it must be accepted as very doubtful whether acetone in the spinal fluid has any clinical significance or can account for any of the cerebral symptoms in the severely toxic cases.

METHODS

The determinations of sugar in blood and in cerebrospinal fluid were made according to the method of Folin,[12] but in preparing the protein-free filtrate from spinal fluid, one-half the usual quantities of sodium tungstate and two-thirds normal sulphuric acid solutions were used, water being added to make the dilution 1 : 10.

For nonprotein nitrogen, in blood and in spinal fluid the same filtrates were used, but on account of the usually low concentration of this group of substances in spinal fluid, 10 c.c. was taken, rather than 5 c.c. as in blood. The nonprotein nitrogen method is that of Folin and Wu.[13]

Total nitrogen in plasma and in spinal fluid was determined according to the procedure of San Yin Wong,[14] and occasionally the work was checked with the older method of Kjeldahl. In this connection, several samples of potassium persulphate were found to bear heavy traces of nitrogen, but this difficulty was overcome by recrystallizing the salt.

The difference between the nonprotein nitrogen content and the total nitrogen, when multiplied by 6.25, was taken as the protein content. It seems possible that an unknown factor for error exists in the accepted methods for precipitation of proteins. In view of the conception of d'Herelle that the smallest possible particle of protein cannot be a molecule but a micella, it seems hardly reasonable to assume that all proteins are precipitable by tungstic acid, trichloracetic acid, and various other coagulants. It is true that the filtrates are negative to Millon's

11. Genoese, G.: Richerche sull' acetone rachidiano in malattie della infanzia deccorenti con acetonuria, Pediatria **31**:23, 1923.
12. Folin, O.: J. Biol. Chem. **38**:98 (May) 1919.
13. Folin, O., and Wu, H.: J. Biol. Chem. **38**:81 (May) 1919.
14. San Yin Wong: J. Biol. Chem. **55**:431, 1923.

test, the biuret reaction, the xanthroproteic reaction, etc., but these reactions, as is well known, are specific for certain groups which are thought to be contained in most proteins rather than for the hypothetic protein molecule itself.

For chlorids in whole blood, in blood plasma, and in spinal fluid, Van Slyke's [15] newer method was followed.

For calcium in serum and in spinal fluid Kramer and Tisdall's [16] procedure was found applicable.

The determination of inorganic phosphorus in whole blood was carried out according to Tisdall's method,[17] on a trichloracetic acid filtrate, of which 10 c.c. was equivalent to 1 c.c. of blood. In applying the method to spinal fluid, it was found convenient to make the dilution 1:5 rather than 1:10, as 10 c.c. of the higher concentration of spinal fluid contains normally an amount of phosphorus comparable to the usual standard for blood.

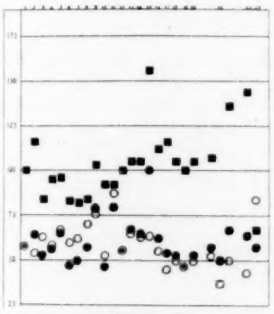

Chart 8

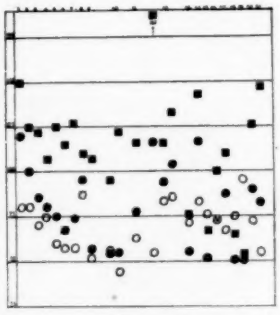

Chart 9

Chart 8.—Relative and absolute blood and spinal values in twenty-three normal cases. In Charts 8 to 12 inclusive, the blood sugar is represented by solid blocks; the spinal fluid sugar by solid circles. The figures are in milligrams per hundred cubic centimeters. The percental relation is represented by open circles.

Chart 9.—Relative and absolute blood and spinal sugar values in twenty-one cases of meningismus, tetany, acidosis and nephritis.

COMMENT

We have considered the chemical composition of the spinal fluid and its alteration in disease, but so far have made no attempt to account for these changes. It is admitted at once that we can only theorize about this. The evidence available does not warrant positive statements.

In any consideration of the spinal fluid, the first question is that of the formation, or origin, and the absorption, or ultimate destination. Weed,[18] in a review of the anatomy and physiology of the spinal fluid,

15. Van Slyke, D. D.: J. Biol. Chem. **58**:523 (Dec.) 1923.
16. Kramer, B., and Tisdall, F. F.: J. Biol. Chem. **47**:475 (Aug.) 1921.
17. Tisdall, F. F.: J. Biol. Chem. **50**:329 (Feb.) 1922.
18. Weed, L. H.: Physiol. Rev. **2**:171 (April) 1922.

thinks that the choroid plexus acting as a secreting gland is the chief source of the spinal fluid, and that there is anatomic evidence that the perivascular spaces also pour a certain amount of fluid into the subarachnoid space in which it mixes with the fluid formed in the ventricles. He thinks a constant elaboration of the fluid is indicated.

From the work of Weed and others it seems to be well proved that the major part of the absorption of spinal fluid is directly into the venous sinuses by way of the villi, a process of filtration from a

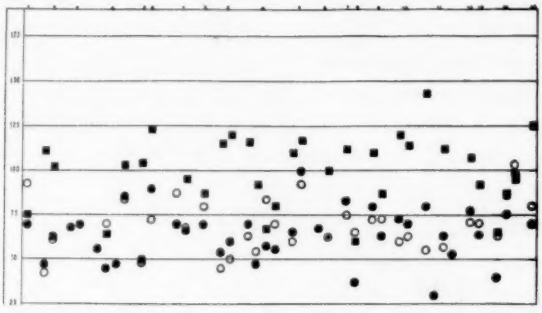

Chart 10.—Relative and absolute blood and spinal sugar values in twenty-one cases of poliomyelitis and encephalitis.

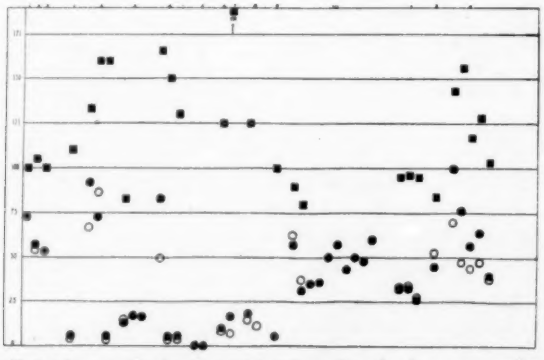

Chart 11.—Relative and absolute blood and spinal sugar values in thirteen cases of chronic, purulent and syphilitic meningitis.

point of high pressure to a point of lower pressure. Weed also demonstrated a minor absorption by way of the lymphatic system. The circulation is from the plexus to the lateral ventricles, to the third ventricle, to the aqueduct of Sylvius, to the subarachnoid space. From the cistern in the region of the cerebellobulbar angle, the fluid slowly seeps down into the spinal subarachnoid space.

Most workers, in attempting to account for the changes in composition of the spinal fluid in disease, offer as possible explanations (1) change in composition of the blood; (2) change in permeability of

the choroid plexus by disease or toxin of disease; (3) bacterial activity.

1. Sufficient evidence is at hand to warrant the assumption that for certain substances there is a parallelism between the blood and spinal fluid chemistry. Spinal fluid sugar in subjects free from meningeal disease usually follows the blood sugar. This is shown in cases of diabetes, following insulin administration. Yet this parellelism between blood and spinal fluid sugar is not constant. An altered relation is found occasionally in our normal group and in other patients without meningeal disease. The amount of calcium, phosphorus, chlorids and protein in the spinal fluid is not dependent on the level of these substances in the blood. Therefore hypothesis number one is not by itself adequate.

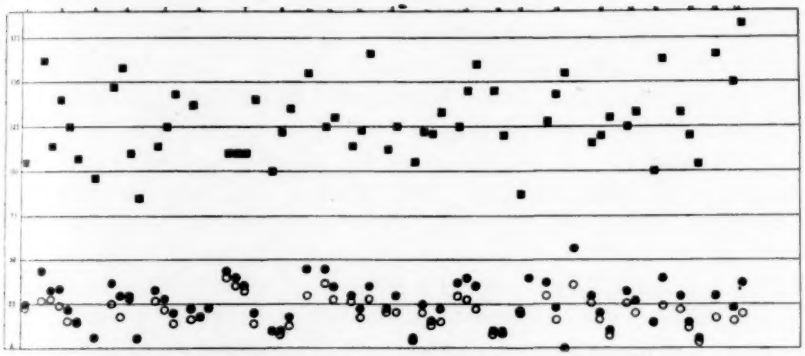

Chart 12. Relative and absolute blood and spinal sugar values in twenty-four cases of tuberculous meningitis.

2. Change in the permeability of the choroid plexus would seem to be the logical explanation for many of the changes in the composition of the spinal fluid in disease. The choroid plexus called by Stern "the hemato-encephalic barrier," functions as a very delicate selective mechanism in the formation or composition of the spinal fluid. Normally it keeps the sugar, chlorids, etc., at a fairly constant level and one totally different from that of the blood. Many workers have assumed that an injury to the choroid plexus in disease brings about an increased permeability which allows the passage of substances present in the blood at an increased rate. There is good evidence that this is so.

Stern,[19] after injecting bacterial toxins (diphtheria, tetanus, and tuberculous), found a diminished resistance to the passage of sodium ferrocyanid from the general circulation. Milian quotes many examples of increased permeability of the choroid plexus to iodids in tuberculous, syphilitic and epidemic meningitis.

19. Stern, E.: Schweiz. Arch. f. Neurol. & Psychiat. **12**:289, 1923.

Flexner and Amoss [20] found no agglutinins for meningococcus in the spinal fluids of monkeys rendered immune to the organism. But intraspinal injection of normal horse serum or a culture of living meningococci allowed the passage of agglutinins from the blood to the spinal fluid. The rate of passage was affected by the severity of the inflammation induced in the meninges.

Cohen [9] suggests as a general law that "the main factor influencing the chemical composition of the spinal fluid in meningitis is the degree of damage to cells of the choroid plexus and cerebral blood vessels by invading virus or toxin. This impairs the vitality of these cells and increases their permeability and thus causes the cerebrospinal fluid to approximate to the blood plasma in chemical composition."

In disease, the substances which are increased in the spinal fluid are sugar, protein and phosphorus. In a disease such as encephalitis, without much if any meningeal inflammation, a high sugar actually and relatively and a moderately high protein are usually present. The increase in sugar and protein here might readily be explained by increased permeability of the choroid plexus and the cerebral vessels. Yet if this is the factor at work, why does it not also allow the passage of chlorids and phosphorus at an increased rate? Both of these substances are present in normal amounts in this disease. In acute and tuberculous meningitis, there is an enormous increase in protein. This could be just as well explained as the normal protein content of an inflammatory exudate as to say that it is due to increased permeability of the choroid plexus. In these two diseases there is also a greatly diminished sugar and chlorid content. Increased permeability of the plexus may account for those changes that represent an exchange from a fluid of high to one of low content, but cannot explain a coincident increase of sugar in the blood and decrease in the spinal fluid.

3. It is admitted that the pyogenic organisms utilize sugar, but *B. tuberculosis* does not, and, so far as is known, none of the organisms causing meningitis utilize chlorids.

Another factor which has not been sufficiently considered is the probable interference with the circulation of the cerebrospinal fluid in acute and tuberculous meningitis. A consideration of the following facts is important in this regard. In purulent meningitis a block is of frequent occurrence, and it is easy to understand that a thick fluid will not circulate as freely as normal fluid. In tuberculous meningitis, which is usually a basilar meningitis, the later taps are not under increased pressure; in fact, they are commonly under decreased pressure which might be taken to indicate a partial block. Further evidence pointing toward an interference with circulation is the occasional normal sugar

20. Flexner, S., and Amoss, H. L.: J. Exper. Med. **28**:11 (July) 1918.

and chlorid content of spinal fluid found early in the course of acute and tuberculous meningitis. This is found more frequently in private practice when taps are done earlier than in the hospital patient. Then, too, there is a difference in the composition of the ventricular and spinal fluids. For most substances the spinal fluid is slightly lower than the ventricular fluid. In one case of chronic basilar meningitis with hydrocephalus, not reported in this series, the spinal fluid sugar was 20 mg. with 64 mg. in the ventricular fluid.

From a consideration of the before-mentioned facts, it might be assumed that often the fluid obtained from a lumbar tap may not represent real cerebrospinal fluid, but only that held in a loculus.

TABLE 6.—*Summary of Findings in the Different Case Groups*

	Normal	Metabolic	Anterior Poliomyelitis	Encephalitis	Purulent Meningitis	Tuberculous Meningitis
Chlorids.....	690-750 mg.	690-750 mg. may be high in nephritis	Usually normal; occasionally low	690-750 mg.	600-690 mg.	600-690 mg.
Protein.....	30-80 mg.	Normal; usually high in meningismus and nephritis	30-500 mg.	30-500 mg.	150-2,000 mg.	80-1,000 mg.
Sugar.....	40-60% of blood sugar	Relative or absolute; increase common	Normal bulbar type; gives relative and absolute increase	Absolute and relative increase	First taps may be normal; later taps low relatively and absolutely	First taps show low normal absolutely but low relatively; later taps low absolutely and relatively

CONCLUSIONS

1. The normal chlorid content of the spinal fluid is from 690 to 720 mg. per hundred cubic centimeters. Low values are found in acute and tuberculous meningitis. The relation of spinal fluid chlorids to blood chlorids is not constant, and a determination of blood chlorids is not necessary or useful in diagnosis.

2. The normal protein content of spinal fluid is from 30 to 80 mg. per hundred cubic centimeters. It is increased in acute and chronic inflammations of the meninges and brain substance. In certain altered metabolic states accompanying infections or nephritis, some increase in protein can be expected.

3. Spinal fluid sugar should always be determined in relation to blood sugar. The normal relative value is from 40 to 60 per cent. of the blood sugar. High relative values are found consistently in epidemic encephalitis, meningismus, convulsions, acidosis and nephritis, in poliomyelitis of the bulbar type and in a certain number of so-called normal cases. From the variety of cases in which a high relative value

is found, it will be seen that this is not a reliable diagnostic point. Low relative values are found in acute and tuberculous meningitis with great regularity, and this is of considerable importance diagnostically.

4. Table 6 best shows what conclusions may be drawn as to the differential value of spinal fluid chemistry.

5. Normal spinal fluid findings are to be expected in just such conditions as are found in Group 1.

6. The character of the toxin at work apparently determines to some extent the degree of general or selective change in choroidal permeability.

7. Chlorids, protein and sugar are likely to vary directly with the acuteness of the infective process. They may bear some constant relation to the disease itself.

8. A knowledge of spinal fluid chemistry is helpful diagnostically in many conditions of the central nervous system; according to the experience obtained in this series, most strikingly so in tuberculous meningitis, less so in purulent meningitis, encephalitis and poliomyelitis.

9. Calcium and phosphorus in the spinal fluid bear no relation to their content in the blood or to the clinical condition of the patient.

GASTRIC DIGESTION IN NEW-BORN INFANTS *

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NEW HAVEN, CONN.

Considerable data have accumulated concerning gastric digestion in infants, especially from the end of the first month to the end of the first year. Of digestion in new-born infants, relatively little is known. In other respects, such as acid base equilibrium, basal metabolism and hemoglobin content, very young babies differ considerably from older infants. In this study, gastric contents were removed from unfed infants soon after birth. The purpose was to find whether the material resembled gastric juice. The p_H was determined colorimetrically and the buffer value measured. On the fifth and the tenth day of life, a special test meal was given, which was withdrawn in one hour, and similar determinations made. The results obtained show striking differences between new-born and older infants, and have not only a theoretic but also a practical importance.

As early as 1874, Zweifel [1] demonstrated the presence of pepsin in the gastric mucosa of new-born infants, and a few years later, Langendorff [2] found it in the mucosa of a four months' fetus. Apparently no work on the hydrochloric acid content was done. In 1892, Szydlowsky [3] found free hydrochloric acid and rennin in the stomach of an unfed new-born infant, aged 7 hours. Hess,[4] in a series of fifty-five unfed infants, aged from 30 minutes to 18 hours, found greatly varying amounts of free hydrochloric acid in the stomach contents. He used congo paper and Toepfer's reagent as tests. Every case but one yielded hydrochloric acid, despite the fact that no food was given to stimulate secretion. Rennin, pepsin and lipase were also found. Pollitzer,[5] in 1921, in a series of 100 unfed new-born infants, introduced catheters, and always obtained a small amount of gastric contents, averaging from 2 to 3 c.c. This liquid, often clear, was usually turbid, contained mucus and sometimes blood. Coagulable albumin was consis-

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* From the Departments of Gynecology, Obstetrics and Pediatrics, Yale University.

* Work done in partial fulfillment for the degree of Doctor of Medicine at Yale University, 1924.

1. Zweifel, O.: Untersuch. ueber d. Verdauungs apparat. d. Neugeb., 1874. Cited by Hess (footnote 4).

2. Langendorff, O., cited by Hess: Arch. f. Anat. u. Physiol. **29**:95.

3. Szydlowsky, cited by Hess: Jahrb. f. Kinderh., 1892.

4. Hess, A. F.: The Gastric Secretion of Infants at Birth, Am. J. Dis. Child. **6**:264 (Oct.) 1913.

5. Pollitzer, R.: Gastric Secretion in New-Born, Pediatria **29**:253 (March 15) 1921.

tently present. The color and constant presence of albumin seem to indicate the presence of amniotic fluid ingested during birth. Using methyl orange and Günzberg's reagent, he showed that free hydrochloric acid could be demonstrated soon after birth. A quantity of the swallowed amniotic fluid is also bound to the alkalis, and probably to the proteins. Pollitzer, like Hess, found individual differences in the amount and concentration of the hydrochloric acid, and puts forth the theory that this may depend partly on the quality and quantity of amniotic fluid ingested, and partly on the secretory activity of the gastric mucosa. Banu, Negresco and Heresco [6] did not find any free hydrochloric acid present in the gastric contents of new-born infants until the sixth day of life.

In none of the foregoing studies was the hydrogen ion concentration measured. The importance of this method, in contradistinction to titration, is well shown by Michaelis and Davidsohn.[7] Hahn [8] states that the determination of the hydrogen ion concentration is the only rational method of measuring gastric acidity in infants.

Studying gastric juice, Tangl [9] showed that the p_H values range from p_H 1.3 to 1.8. He also determined the combined acid values, obtaining figures varying from 4 to 10. These are the buffer values expressed as cubic centimeters of normal sodium hydroxid per hundred cubic centimeters of gastric juice.

MATERIAL

Twenty-five babies were observed. All were born in the Obstetrical Pavilion of the New Haven Hospital. Five of the deliveries were effected by low forceps, and one by cesarean section. There was one breech presentation and one face presentation in the series. The remaining seventeen were normal deliveries. All birth weights were within the normal limits as given by J. W. Williams, and at the time of discharge from the hospital, which averaged fourteen days from delivery, the majority of the infants had regained or exceeded their birth weights. Twenty-one were entirely breast fed, and four received supplementary feedings of a diluted formula of cow's milk and dextrimaltose. Taking into consideration the vital signs, weight, progress and general condition, it may be said that all were normal.

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6. Banu, Negresco and Heresco: Gastric Chemistry in New-Born, Compt. rend. Soc. de biol. **90**:1159 (May) 1924.

7. Michaelis, L., and Davidsohn, H.: Ueber Bedeutung und Messung der Magensaftacidität, Ztschr. f. exper. Path. u. Therap. **8**:398-413, 1911.

8. Hahn, Milton: Gastric Digestion in Infants, Am. J. Dis. Child. **7**:305 (April) 1914.

9. Tangl, F.: Untersuchungen über die Hydrogenienen Conzentration im Inhalte des nüchternen menschlichen Magens, Arch. f. d. ges. Physiol. **115**:64, 1906.

METHODS

The gastric contents were removed by means of a small, soft rubber catheter and placed in test tubes. The apparatus was all carefully washed and boiled in distilled water. Filtration of the contents was accomplished by means of a Gooch crucible, made of asbestos, mounted in a suction flask. The method was that used by Babbott, Johnston, Haskins and Shohl.[10] Determination of the p_H was made by the colorimetric method of Shohl and King.[11]

The buffer values were obtained by titrating with a tenth normal sodium hydroxid solution in a microburet, from p_H 3.0 to p_H 9.6. The results were expressed as cubic centimeters of tenth normal sodium hydroxid, per hundred cubic centimeters of the solution titrated. "Buffer value" is equivalent to combined acidity when free acid is present, or to the sum of total or combined acidity and acid deficit when no free acid is present. The method was that of Shohl and King.[11]

RESULTS

From fifteen minutes to fourteen hours after birth, the contents were withdrawn from the infants' stomachs. Although little or no trouble was encountered in obtaining the material, the amount of gastric contents was invariably small, averaging 4.5 c.c. In all cases an attempt was made to remove all the contents, and it may be stated with reasonable assurance that practically all was removed, with the exception of thick mucus, which failed to pass through the catheter. The character of the contents was quite constant in twenty-two cases, being a clear, colorless, watery solution, containing a moderate amount of thick, white mucus. Of the remaining three, one was greenish and contained much mucus, another was opalescent and very mucoid, while the third was dark brown and relatively free from mucus. Table 1 and Figure 1 show the data obtained. The p_H values of the gastric contents of this group, averaging 4.6 hours after birth, ranged from p_H 1.7 to 4.4. The average for the group was p_H 2.6. Fifty-two per cent. were between p_H 2.6 and 3.0, and 88 per cent. were more acid than p_H 3.0. The buffer values ranged from 5 to 15 c.c., 56 per cent. being 10. The average is 9.4 c.c.

The gastric contents of an unfed infant 2 hours old, who had been delivered by version and extraction, were also obtained. Two days later this baby died from extensive intracranial hemorrhages incurred

10. Babbott, F. L.; Johnston, J. A.; Haskins, C. H., and Shohl, A. T.: Hydrogen Ion Concentration of Gastric Contents of Infants, Am. J. Dis. Child. **26**:475 (Nov.) 1923.

11. Shohl, A. T.: Determination of the Acidity of Gastric Contents Determination and Significance of Acidity, Bull. Johns Hopkins Hosp. **31**:152 (May) 1920.

TABLE 1.—*Gastric Contents of Unfed New-Born Infants*

No.	Time Removed (Postbirth)	Amount, C.c.	p_H	Buffer Value, C.c. of Tenth Normal Sodium Hydroxid per 100 C.c.
1	2½ hours	5	3.2	10
2	5 hours	4	1.7	10
3	10 hours	4	2.4	10
4	2 hours	2	4.4	10
5	8 hours	10	1.9	15
6	6 hours	8	1.8	15
7	4 hours	4	1.7	10
8	10 hours	4	2.1	10
9	1 hour	10	3.7	5
10	10 hours	4	3.0	5
11	14 hours	3	2.1	10
12	9 hours	4	2.7	5
13	3 hours	3	1.7	10
14	3 hours	3	3.0	10
15	12 hours	2	2.1	10
16	3 hours	3	2.9	12
17	30 minutes	6	2.8	5
18	30 minutes	3	2.9	5
19	15 minutes	2	2.8	10
20	5 hours	4	2.6	10
21	2 hours	5	3.0	10
22	1 hour	3	2.6	12
23	3 hours	3	2.9	8
24	15 minutes	7	3.0	10
25	35 minutes	8	2.8	8

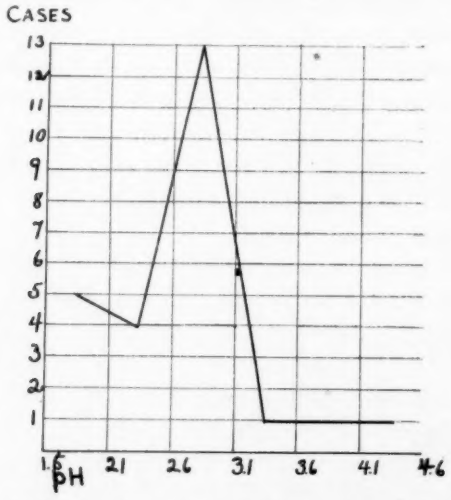

Chart 1.—The hydrogen ion concentration of unfed new-born infants' gastric content.

at the time of delivery. The contents differed in many respects from those of the regular series. There was 5 c.c. of a cloudy, yellowish, blood-tinged liquid, with a p_H value of 4.6, the highest figure encountered. The buffer value was 10 c.c.

FIFTH AND TENTH DAYS

On the fifth day after birth, the test meal, consisting of 4 gm. of Dryco (a dry, partly skimmed milk preparation) in 50 c.c. of distilled water, was substituted for a regular breast feeding, and the gastric contents were removed exactly one hour after the feeding was begun.

The time required for taking the feeding was from five to ten minutes.

The quantity obtained was small, averaging 6.5 c.c. The character of the contents was the same as on the first day of life in unfed infants.

TABLE 2.—*Gastric Contents Removed One Hour After Fifty Cubic Centimeters of Test Meal, at the Age of Five Days*

No.	Amount, C.c.	p_H	Buffer Value, C.c. of Tenth Normal Sodium Hydroxid per 100 C.c.
1	20	2.1	15
2	8	2.0	35
3	3	2.3	12
4	3	2.2	5
5	2	2.4	10
6	15	2.6	20
7	6	2.7	5
8	6	2.7	10
9	Omitted, baby ill		
10	4	2.7	10
11	15	2.1	15
12	3	2.8	5
13	4	2.2	5
14	5	2.6	12
15	4	2.4	5
16	5	2.6	20
17	5	2.6	10
18	5	2.7	10
19	4	2.1	12
20	3	2.8	12
21	3	2.8	12
22	5	2.2	10
23	5	2.5	10
24	3	2.6	12
25	4	2.6	10

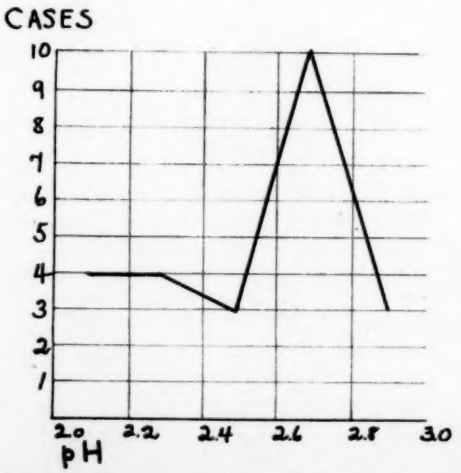

Chart 2.—The hydrogen ion concentration of gastric contents of infants 5 days old, removed one hour after test meal.

The data are given in Table 2. The p_H values ranged from p_H 2.0 to 2.8, with an average of p_H 2.5. Thirty-five per cent. lay between p_H 2.0 and 2.4, the remaining 65 per cent. being between p_H 2.5 and 2.8. The buffer values varied from 5 to 35 c.c., 58 per cent. being between 10 and 12 c.c.

On the tenth day after birth, the procedure was repeated with the same test meal. Table 3 gives the data. The quantity of contents removed averaged 4.9 c.c. The character of the contents did not differ from that recovered on the first and fifth days of life. The p_H values varied from p_H 2.1 to 3.0, an average of p_H 2.5. Of these, 72 per cent. ranged from p_H 2.4 to 2.7.

TABLE 3.—*Gastric Contents Removed One Hour After Fifty Cubic Centimeters of Test Meal, at the Age of Ten Days*

No.	Amount, C.c	p_H	Buffer Value, C.c. of Tenth Normal Sodium Hydroxid per 100 C.c.
1	3	2.2	13
2	20	2.6	12
3	3	2.1	10
4	3	2.7	8
5	3	2.6	12
6	3	2.8	5
7	8	2.4	10
8	8	2.6	12
9	4	2.6	10
10	3	2.4	10
11	3	2.6	12
12	6	2.6	5
13	3	2.3	20
14	4	2.4	15
15	6	2.7	12
16	4	2.8	10
17	4	2.7	12
18	6	2.4	15
19	3	2.6	10
20	5	2.4	10
21	6	2.8	10
22	2	2.4	10
23	4	2.4	10
24	4	2.4	10
25	5	3.0	10

TABLE 4.—*Gastric Contents Removed at Birth, and at the Age of Five and Ten Days. Average Results*

	At Birth	Five Days	Ten Days
p_H	2.6	2.5	2.5
Amount, c.c.	4.5	6.5	4.9
Buffer value, c.c. of tenth normal per 100 c.c.	9.4	11.8	10.8

The buffer values varied from 5 to 20 c.c., 76 per cent. of them being between 10 and 12 c.c. The values obtained for the study at five days are so similar to those at ten days that both have been combined and shown graphically in Figure 4.

Table 4 gives average findings for the entire seventy-five readings.

An attempt was made to secure a series of figures on the gastric contents of the same babies at periods varying from one to two months after discharge from the hospital. One baby only was available, returning almost two months after discharge. The same test meal was used,

and the contents removed one hour later. They were somewhat curdy in appearance and gave a p_H value of 3.4 by the electrometric method. A buffer value was not obtained. This p_H is higher than the earlier values, and is in accord with the figures for this age.

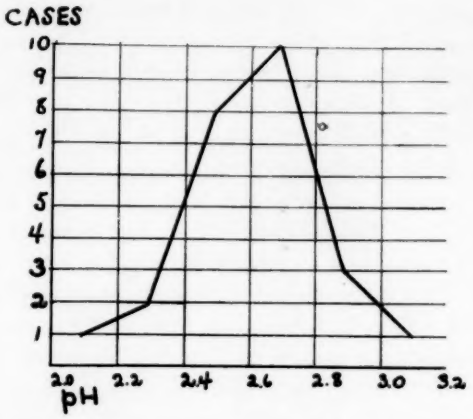

Chart 3.—The hydrogen ion concentration of gastric contents of infants 10 days old, removed one hour after test meal.

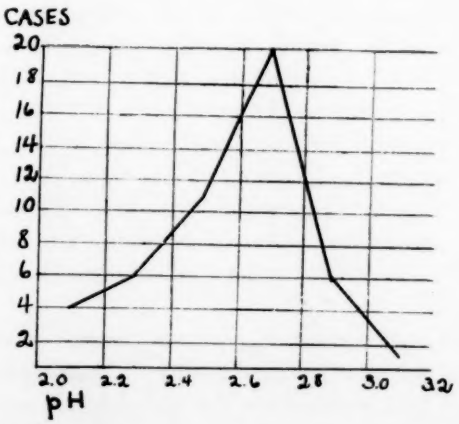

Chart 4.—The hydrogen ion concentration of gastric contents of infants 5 and 10 days old, removed one hour after test meal.

COMMENT

The p_H values for the gastric contents of unfed infants agree with those in the literature which were obtained by titration. They demonstrate the presence of free hydrochloric acid. The p_H 2.6 was less acid than that of Tangl[9] (p_H 1.3 to 1.8) for pure gastric juice. But no

other excretion or secretion of the body could yield so acid a reaction; the material was unquestionably gastric juice.

Our buffer values approximated those of other workers who used pure gastric juice. Tangl, taking congo red and phenolphthalein as indicators, reports buffer values of from 4 to 10 c.c. Sommerfeld and Roder,[12] in a girl with an esophageal fistula, report buffer values of from 12 to 17 c.c. Buffer values for unfed new-born infants are 9.4.

Just what constitutes the stimulus to this secretion of hydrochloric acid is not known. Pollitzer holds to the view that the ingestion of amniotic fluid during labor is responsible because he found albumin in the gastric contents. However, he does not show that this albumin decreases with increase of acid, nor that albumin is absent from the gastric secretion; nor does he demonstrate the presence of any characteristic salt of amniotic fluid recognizable by p_H or other chemical means. The presence of food is not necessary to stimulate the secretion of gastric juice. It may be reflex, from sucking, "psychic" or due to hunger, and may normally precede the ingestion of food in an infant.

Faber,[13] in 1923, stated that in very young infants proportionally much less digestion is gastric, and more is intestinal, the latter being optimal in alkaline reaction. He, therefore, says that it might be well to increase the alkalinity of artificial food during the first month, or at least to prevent using acidified milk. This conclusion cannot be substantiated from the point of view of gastric analysis.

The p_H values of the gastric contents withdrawn one hour after a test meal in the new-born infants are more acid than those of a group of infants ranging from 3 to 19 months of age. The p_H averaged 2.5 and 2.6 for the new-born infants; for the older infants, 76 per cent. of the values lay between p_H 3.9 and 4.6. At the end of one hour, after the ingestion of a partly skimmed milk mixture, digestion in new-born infants has been completed. This is shown by the high hydrogen ion concentration, the low buffer value and the small volume of gastric contents recovered.

These infants undoubtedly have an increased capacity for hydrochloric acid secretion and gastric digestion. This capacity may be due to an altered acid base equilibrium, the true acidosis which Ylppö [14] has described. Practically, it would seem logical to feed-new born infants a more concentrated and a more alkaline food.

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12. Sommerfeld, P., and Roeder, H.: Ueber das physikalische Verhalten von Losungen in menschlichen Magen, Berl. Klin. Wchnschr., December, 1924.

13. Faber, H. K.: Hydrochloric Acid Milk in Infant Feeding, Am. J. Dis. Child. **26**:401 (Nov.) 1923.

14. Ylppö, A.: Neugeborenen-, Hunger-, und Intoxikations-Acidosis in ihren Beziehungen zueinander, Ztschr. f. Kinderh. **14**:268-448, 1916; ibid., Beitrag zur Azidosis bei Neugeborenen, Acta Paediat. **3**:235-261, 1924.

SUMMARY

1. The gastric contents of unfed new-born infants consists of gastric juice which contains free hydrochloric acid. The average p_H is 2.6. The buffer value is 9.4 c.c. The volume is 4.5 c.c.

2. At 5 days of age, test meals removed in one hour show an average acidity of p_H 2.5, a buffer value of from 10 to 12 c.c. and a volume of 6.5 c.c. Similar values were obtained on the tenth day.

3. The capacity for gastric digestion is greater in new-born infants than later in infancy. Gastric digestion of 50 c.c. of partly skimmed cow's milk is practically complete in one hour. It would seem logical to feed new-born infants a more concentrated and a more alkaline food.

PROGRESS IN PEDIATRICS

IMPORTANCE OF CONSIDERING THE BODY MECHANICS OF CHILDREN *

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NEW YORK

In examining a child the physician investigates carefully the throat, the heart, the lungs and the abdominal organs. Too frequently he completely ignores the skeletal system unless there is a marked lordosis, an obviously protruberant abdomen or flat feet. When the attention has once been drawn to the question of body mechanics, it becomes evident that few children hold themselves in good position. It is my object in this paper to call attention to the necessity of considering the posture of every child, and to present reasons for this necessity.

Good body mechanics means [1] that the body is maintained in such a position that there is no undue strain on any set of muscles or organs. The head is held erect with chin in: the chest is up with costal angle wide: the abdomen is held in instead of sagging down. The weight of the body is forward on the balls of the feet, not on the heels. In this position the individual is able to breath deeply, the intestines have needed support, the shoulders are not pushed forward and the curves of the back are not exaggerated. In considering posture the anatomic type of the individual must be taken into account. Three types are easily recognizable: (1) the broad or "herbiverous," (2) the congenital visceroptotic, or "carniverous" and (3) the normal. The first type shows less exaggerated bad posture but is most difficult to correct. The second type may exhibit extremely bad body mechanics, but because of the greater flexibility of the body this is more easily improved. Goldthwait [2] has clearly described these variations.

During the war the number of men regarded as physically unfit was appalling. It is well known that many of those classed as fit went to pieces under the stress of war exertions.[3] It is less well known that many of these men who were sent back were given instruction and

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* From the Department of the Diseases of Children, College of Physicians and Surgeons, and Children's Medical Service, Bellevue Hospital.

1. Brown, L. T.: Bodily Mechanics and Medicine, Boston M. & S. J. **182**:649-655 (June 24) 1920.

2. Goldthwait, J. E.: An Anatomic and Mechanistic Conception of Disease, Boston M. & S. J. **172**:881-898 (June 17) 1915.

3. Willard deF. P.: Inefficiency Due to Backstrain and Faulty Posture in Unseasoned Troops, Am. J. Orthop. Surg. **16**:429 (July) 1918.

training in the proper mechanical use of their bodies, and thereafter were able to carry on even under the conditions of war. These findings brought the question sharply to the attention of orthopedists, and during the past ten years more and more attention has been paid to it.

It is true that many people with bad posture have no symptoms and are apparently in excellent health. Lee [4] uses the term "compensated" in this connection in the same sense that it is used in regard to the heart, that is, up to a certain point strong muscles allow activity, but beyond this point symptoms ensue. It must be remembered that poor posture does not tend to correct itself, although, unfortunately, there is usually good compensation for this handicap through young adult life.[5]

In the examination of several classes of Harvard freshmen, although only a small percentage handled their bodies well, the number of those who had complaints which might be ascribed to bad posture was small.[6] On the other hand, those who complained of constipation, abdominal discomfort, backache or who had had the appendix removed fell in classes C and D shown in the chart. Examination of several thousand Yale freshmen [7] showed that only 25 per cent. had normal spinal curves, more than 50 per cent. had some scoliosis, and more than 50 per cent. had increased anteroposterior curves. Flat chest was found in 65 per cent. and abnormally prominent abdomens in 42 per cent.

The question of the cause of any condition is vital, as it is futile to try to correct a condition while the causative factor still obtains. As the basis of poor posture lies the fact that our bodies were originally designed for the four-legged position, and we have not yet fully evolved a mechanically perfect two-legged state. Even now, one out of five people [8] is born with the abdominal viscera in the state which exists in the lower animals, i. e., there is a mesocolon and longer supporting ligaments. This combined with the force of gravity tends to allow sagging of the abdominal organs. Also, some individuals have congenitally relaxed muscles and tendons, and of course fall more easily into a poor posture.[9] Once the abdomen has started to sag, the other factors

4. Lee, R. I., and Brown, L. T.: Correction vs. Compensation of Physical Defects, Am. J. M. Sc. **160**:651, 1920.

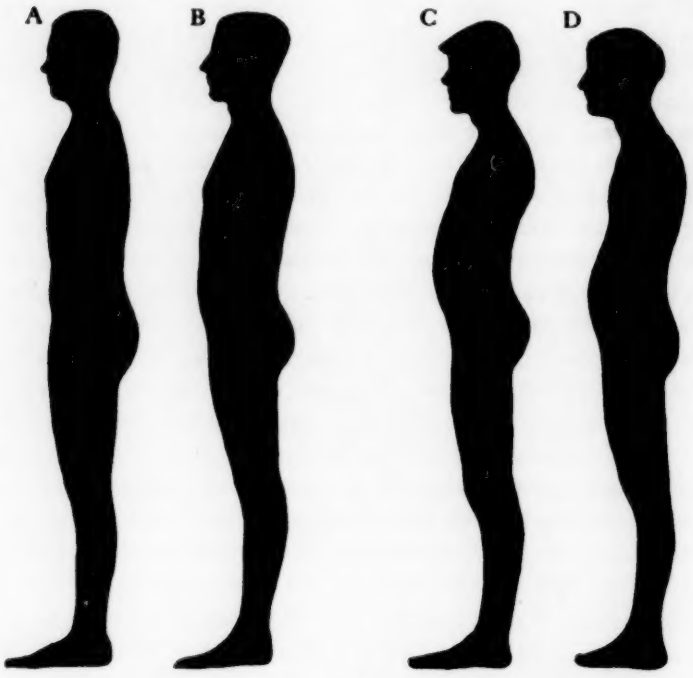
5. Lee, R. I.: Some Confessions of an Internist Concerning Body Mechanics, J. Bone & Joint Surg. **5**:747-752 (Oct.) 1923.

6. Brown, L. T.: Bodily Mechanics and Nutrition, Boston M. & S. J. **182**:187-191 (Feb. 19) 1920.

7. Cook, R. J.: Results of Exercises for Correction of Postural Defects, New York State J. M. **117**:155 (Feb.) 1923.

8. Goldthwait, J. E., and Brown, L. T.: The Recognition of Congenital Visceral Ptosis in the Treatment of the Badly Poised and Poorly Nourished Child, Am. J. Orthorp. Surg., Vol. 9, November, 1911.

9. Dickson, F. D.: Effect of Posture on the Health of the Child, J. A. M. A. **77**:760 (Sept. 3) 1921.



A and *B* indicate the right posture; *C* and *D*, wrong posture.

(A) Excellent Mechanical Use of the Body

1. Head straight above chest, hips and feet.
2. Chest up and forward.
3. Abdomen in or flat.
4. Back, usual curves not exaggerated.

(B) Good Mechanical Use of the Body

(Compare with Fig. A)

1. Head too far forward.
2. Chest not so well up or forward.
3. Abdomen, very little change.
4. Back, very little change.

(C) Poor Mechanical Use of the Body

(Compare with Fig. A)

1. Head forward of chest.
2. Chest flat.
3. Abdomen relaxed and forward.
4. Back curves are exaggerated.

(D) Very Poor Mechanical Use of the Body

(Compare with Fig. A)

1. Head still farther forward.
2. Chest still flatter and farther back.
3. Abdomen completely relaxed. "slouchy."
4. Back, all curves exaggerated to the extreme.

(Prepared and issued by the Department of Hygiene and Physical Education, Harvard University, Cambridge, Mass.)

in poor body mechanics develop, namely, the flat chest, forward head, tilted pelvis, round shoulders, sprung knees and knock knees.

When fatigue is added to these conditions, a vicious cycle is established—the more tired a person becomes the worse he stands; the worse he stands, the more tired he becomes because of the undue and unequal muscle strain. Obviously, then, one of the first things to question is the daily regimen of the child from this point of view. Suppose a well-built boy of the broad type is examined. He has strong muscles, but his shoulders are sagging forward, his abdomen is prominent below the umbilicus, and his head is forward. On questioning, it is found that in addition to his regular school hours he spends three afternoons a week boxing, goes to gymnasium two afternoons, swims on Saturday, besides putting in as much time as he can playing ball; in other words, he is in constant activity, with no period for real relaxation. Toward the end of the school year his body begins to show the strain, although at first the only symptom may be irritability. In the same way the school girl is apt to rush off after breakfast. After a morning in school she has a hurried lunch, goes to dancing class, rehearses for a play and then goes to gymnasium or a party. It seems logical that she should be too tired to eat her meals, to sleep restfully at night, or to waken happy in the morning. Different but equally potent factors occur among the poorer classes. Jewish children have their Hebrew school to attend besides public school with its home work. Many practice on some musical instrument. The boys sell papers, the girls scrub floors and lift heavy babies. It is usually possible to put a stop to some of these activities, and if in addition to this the poor body mechanics are corrected, the vicious cycle is broken.

In children there are certain conditions which are definitely relieved or cured by correction of the body mechanics. So far as we get relief we can say that faulty body mechanics was the cause of the condition. These conditions are: (1) Constipation.[10] Unless there is an organic lesion, correction of the body mechanics almost invariably gives relief. The reason seems clear when we consider the fact that an anterior abdominal wall with muscles strong enough to hold it in gives better support to the intestines than a sagging wall. It has been demonstrated that the position of the intestines is raised from 1 to 6 inches when the abdominal wall is properly contracted [11]

(2) We frequently see patients who complain of vague abdominal discomfort. There may be attacks of constipation with fever. Such

10. Talbot, F. B.: Body Mechanics. Its Effect on the Health of Children, South. M. J. **15**:171-175 (March) 1922.

11. Mankell, N., and Koenig, E. C.: Postures and Types of Breathing Exercises, New York State J. M. **104**:935 (Nov. 11) 1916.

cases should be carefully studied in connection with a surgeon to rule out an acute or chronic surgical condition. Many are completely relieved by correction of the body mechanics.[12]

(3) Cyclic vomiting. It has been shown by Talbot[13] that in these cases there is a lack of assimilation of fat. With correction of posture the amount of fat in the stools diminishes or disappears, and the child is able to handle two or three times as much in the diet. The neurotic element is frequently a most important factor in these cases, many of which are closely related to migraine. The attacks may change into typical migraine. Postural treatment and avoidance of overfatigue are logical aids in preventing the attacks. Occasionally an acute attack of appendicitis makes clear the diagnosis of recurrent attacks which have been called cyclic vomiting.

(4) Enuresis. This is almost always a difficult condition to treat, but some children respond surprisingly to posture work. The explanation probably lies in the improvement in their general condition, although there may be an element also in the relief of irritation of the bladder by the sagging abdominal viscera.

(5) The ptosis of the abdominal organs following relaxation of the anterior abdominal wall interferes with the proper functioning of these viscera, particularly of the stomach and intestines. Naturally, then, the nutrition suffers. The extreme thinness of adults with so-called visceroptosis is good evidence that there is a causal relation here.[14] Many of the children found in nutrition classes fall into the slender visceroptotic class and are frequently the ones who prove most refractory to treatment. When such children have their body mechanics improved there is almost always a gradual but steady gain in weight. This assumes that there is no underlying cause, such as active tuberculosis, to retard progress, and that the child's efforts to assist in the correction of the defect is sincere. Children of tnat type should not be judged by the standards of weight adopted as the average; as their anatomic build is lighter, their bones weigh less.

(6) Scoliosis and pronated feet are sometimes secondary to poor posture. In uncomplicated cases this functional scoliosis disappears with

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12. Tenant, C. E.: Faulty Posture Causing Abdominal Pain Simulating Symptoms Associated with Visceral Pathology, Colorado M. **20**:191-196, (July) 1923. Nicholson, P.: Faulty Posture as Cause of Obscure Digestive and Nutritional Disorders, Penn. M. J. **26**:296-303 (Feb.) 1923.

13. Talbot, F. B., and Brown, L. T.: Bodily Mechanics, Its Relation to Cyclic Vomiting and Other Obscure Intestinal Conditions, Am. J. Dis. Child. **20**:168 (Sept.) 1920.

14. Osgood, R. B.: What Evidence Can be Brought Forward to Show that Visceroptosis is Anything More than a Variation from an Anatomic Norm and is of Frequent Causative Clinical Significance? Am. J. Orthop. Surg. **14**:533 (Sept.) 1916.

correction of body mechanics, and the feet tend to assume a better position. When the foot pronation is extreme the child should, of course, be referred to an orthopedist.

Besides these definite conditions which are frequently corrected by improving the body mechanics, it is surprising to see the improvement in the general condition of the children. Often the mother or nurse will volunteer the information that the child is less restless and irritable, or that his disposition has entirely changed. Such evidence is good proof that the correction was necessary to his well-being. By making these corrections in childhood we may be saving the world from a certain number of dyspeptic and hypochondriac persons.

TREATMENT

The first essential in attempting to correct the body mechanics of a child is to explain to the parents and nurse the reasons for the need and to demonstrate the position of the body which is most desirable; in other words, it is necessary to educate the adults as their cooperation is vital. The use of a chart or diagram is helpful. It is also necessary to get the interest of the child. Those 6 years old or older are most easily handled, as they are able to grasp the meaning of the work and to put some intelligent and conscious effort into it. Younger children can be taught the exercises, but the "will to do" must be supplied by the mother or nurse. Results with them are always slower in appearing. It is surprising to see the interest that the children show, particularly if there is some definite object in mind which appeals to them; for instance, tell a boy that when his abdominal muscles are flat and hard he will not be easily hurt in football, and he will show much more enthusiasm than if he is trying to overcome constipation. Even in a group from the dispensary in which less individual attention can be shown, the children show a remarkable faithfulness in attending the class and doing the exercises at home.

Every possible factor which tends to cause poor posture must be eliminated. The mattress of the bed should be firm, and no pillow should be used. If an underwaist is worn, the straps should go over the base of the neck rather than over the tips of the shoulders, as this is often an element in bringing the shoulders forward. Bloomers with elastic around the waist are bad. If the elastic is tight enough to hold the garment up, it pushes the abdomen down even though the pressure is slight. Side garters fastened to an improperly fitted waist exert a strong influence in bringing the shoulders forward. Children should have chairs which are of the proper size.[15] The most important factor

15. Goldthwait, J. E.: The Importance of Correct Furniture to Assist in the Best Body Function, J. Bone & Joint Surg. **5**:179-184 (April) 1923.

here is the depth of the chair seat, which should be narrow enough to allow the legs to hang down without forcing the child to slump on the end of his vertebral column. Children who have proper sized chairs in the nursery are often given adult chairs at the dining table. If this is necessary, pillows should be put behind to give the back support. Some dancing classes teach steps of the ballet type which are distinctly bad from the point of view of posture. The steps which are taught "at the bar" put the feet into extreme abduction, and many of the positions cannot be performed with the body in good mechanical position. It seems to me that all these points come within the province of the pediatrician as factors which may be harmful to the child.

All unnecessary activities should be eliminated. In the case of small children and those with bad posture and malnutrition, it is advisable to insist on a rest in an overcorrected position, preferably after each meal, but in any case after the noon meal, for from twenty to thirty minutes. The simplest position to take is lying on the back on a firm flat surface such as the floor, with a small roll or pillow under the lower part of the thorax.[16] The hands are placed behind the neck, and the shoulders and elbows rest on the floor. The level of the anterior chest wall thus is brought a little above the level of the face. The lower ribs, which in bad posture are too close together, are lifted up, the intercostal spaces are widened, and the costal angle is increased. The stomach is pulled up into a more nearly normal position and is better able to function. This position becomes comfortable after a time.

The exercises used should have two aims: (1) to teach the child conscious control of the muscles, and (2) to strengthen the muscles so that when the proper position has been learned the child will be able to maintain it. The first is sometimes difficult to attain, but with patience it can always be done. Control of the abdominal muscles is really the key to the situation. Until this has been achieved, it is better to use the simple and fundamental exercises in the recumbent position. No exercises should be given that cannot be done with the body held in good position, and exercises beyond the strength of the child should be avoided. Those which force the body into a poor posture are worse than none. The reason that some posture work fails is because it is not realized that the muscles to be trained particularly are those of the trunk, and because the exercising is overdone to the extent of overfatigue.

In some cases the child is too small or the muscles so weak that exercises alone are insufficient. When this is so a light abdominal

16. Thomas and Goldthwait: Body Mechanics and Health, Boston, Houghton Mifflin Company, 1916.

support may be given,[17] but it should always be supplemented by exercises and the support removed as soon as possible. A belt alone does not produce good posture.

The response of the children is surprising. They are almost always interested and enjoy having something definite to work for. The psychologic effect of taking photographs or silhouetteographs to show progress is excellent.[18]

Other methods of improving nutrition must not be forgotten. Part of the good results comes from frequent visits to the physician and the reiteration of health lessons.

Results which may be looked for within a few weeks after starting corrective work are: (*a*) improvement in the general condition evidenced by lessened fatigue, more restful sleep and better appetite; (*b*) better temper, less irritability and nervousness; (*c*) brighter facial expression; (*d*) no constipation if present before. Permanent improvement in posture itself occurs sooner in older than in younger children.

CONCLUSIONS

Body mechanics should be considered in the examination of every child. Poor posture is a borderline condition and does not necessarily demand treatment by an orthopedist.

Poor posture is most easily corrected in childhood and should be prevented by removing the factors which tend to cause it, such as overfatigue and improper clothing.

Bad body mechanics should be considered as a potential cause of disease, and its correction as a measure of preventive medicine[19] rather than as a last resort in a difficult case.

In attempting to correct poor posture the fundamental aim must be kept constantly in mind, and the exercises planned accordingly. In simpler cases the patient can be cared for in the office of a pediatrician who understands the problem.

The results obtained are well worth the time and patience required.

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17. Brown, L. T., and Talbot, F.: Use of Supports in Obscure Abdominal Conditions, Am. J. Dis. Child. **21**:347 (April) 1921.

18. Fradd, N. W.: New Method for Recording Posture, J. Bone & Joint Surg., Oct., 1923, p. 757.

19. Goldthwait, J. E.: The Opportunity of the Orthopedist in Preventive Medicine Through Educational Work on Posture, Am. J. Orthop. Surg. **14**:443-449 (Aug.) 1916.

Abstracts from Current Literature

Anatomy and Physiology

Investigations Concerning the Effect of Pituitary Extract. Stefan Weiss and Albert Telbiez, Wein. Arch. f. inn. Med. **10**:401, 1925.

The authors found that pituitary extract will increase resorption from subcutaneous connective tissue. The excretion of fluid taken by mouth is decreased through the administration of pituitary extract.

The effect of this extract in diabetes insipidus was not any different from that generally observed in other patients not suffering from this condition. The authors believe that if pituitary extract has any effect in diabetes insipidus, it has it on the kidney directly.

Schlutz, Minneapolis.

The Cell Elements of the Colostrum. M. Ambrus, Orvosi hetil. **69**:623, 1925.

The breasts begin their functions in the first months of pregnancy. The secretion produced is mostly mucous and contains very little fat, but cell elements are found in great number. The epithelial gland is still mostly polygonal and so it does not fully function. Of the hematogenous elements, the lymphocytes are prevalent, while after birth the leukocytes take their place.

On the first day after birth there is only little fat in the cells, from the second day on the fat content increases rapidly. Together with this, the cell elements disappear and the free fat globules increase in number.

The hematogenous elements have nothing to do directly with milk secretion and fat production; they only prepare the ground for the ensuing function of the gland cells.

On the Duodenal Pylorous Reflex. T. Barsony and E. Egan, Orvosi hetil. **69**:745, 1925.

Experiments were made on human beings using a duodenal tube and controlling the results with roentgen ray.

From 0.2 to 0.36 per cent. solution of hydrochloric acid was injected into the duodenum in a series of experiments. The results were:

1. If the amount and concentration of hydrochloric acid does not exceed the amounts occurring in human pathology, there is no change in the peristaltic tonus and emptying of the stomach, nor in the function of the pylorus.

2. If the amount and concentration of hydrochloric acid exceeds considerably the amounts occurring in human pathology, a muscular depression of the stomach ensues and emptying through the pylorus ceases.

The so-called duodenal pylorus reflex, which formed the foundation of the physiology and pathology of the stomach and duodenum, does not exist. The conception of a duodenal reflex in physiology and the doctrines of pathology based on this reflex have to be discarded.

Zentay, St. Louis.

Pathology, Bacteriology and Biochemistry

The Blood Supply to the Pancreas with Some Perfusion Studies. William S. Collens, J. Biol. Chem. **64**:461, 1925.

Perfusion of the pancreas of a dog with physiologic sodium chlorid solution, does not affect the blood sugar or cause glycosuria. Perfusion of the liver through the hepatic artery with saline solution does cause glycosuria and an increase in the blood sugar.

Higgins, Cincinnati.

PRACTICAL EXAMINATION FOR RENAL INSUFFICIENCY. CHARLES FERGUSON, Northwest Med. **24**:334 (July) 1925.

Ferguson reviews the tests of kidney function. Concentration tests, quantitative dye elimination tests and blood chemistry should be performed. Individual kidney capacity should be determined by ureteral catheterization and chromo-ureteroscopy.

SCOTT, Philadelphia.

A CASE OF HYPERTELORISM. D. C. MUIR, Brit. J. Child. Dis. **22**:102 (April-June) 1925.

The outstanding feature of this condition is the great breadth between the eyes, hence the name "hypertelorism." The term was coined by Greig to designate a hitherto undifferentiated congenital craniofacial deformity.

The case cited is that of a girl, aged 13 months, who was brought to the hospital because of failure to sit up. The birth and family history were entirely normal. The deformity of the head was noticed soon after birth. Apart from this the child was physically well made. The eyes were very widely separated and the bridge of the nose markedly flattened. The eyes appeared to be too small for the sockets, the eyelids being full and bulky. The general appearance and responses of the child strongly suggested mental defect.

Greig was fortunate enough to obtain the skulls of his two patients, and found that the essential change was one of abnormal evolution of that part of the phenoid developed in cartilage; the lesser wings were more solid and more developed than the greater wings. Both patients showed mental defect.

LANGMANN, New York.

ANTIGENIC PROPERTIES OF LYSOZYME-DISSOLVED VACCINES. V. D. ALLISON, Brit. J. Exper. Path. **6**:99, 1925.

Lysozyme is a bacteriolytic substance which has been shown by Fleming and Allison to be present in practically all the secretions and tissues of the human and animal body. The author used the lysozyme of human tears to prepare a vaccine of dissolved *Streptococcus fecalis,* in order to compare its antigenic properties with those of a heat-killed, saline suspension of the same organism. Intravenous injections of both preparations were given to rabbits at weekly intervals, and a study was made of the immunologic reactions of the serums against the *Streptococcus fecalis.*

The animals receiving the dissolved vaccine showed a well marked increase in bactericidal power, as evident as that resulting from the use of heat-killed vaccine, and a formation of specific complement-fixing substances. There was very little rise in opsonic power and none in the bacteriolytic and agglutinating properties. This was in contrast to the increase in the latter properties following the injection of heat-killed vaccine.

These results are in general agreement with those of Douglas who studied vaccines in which the organisms had been digested with trypsin.

NONSPECIFIC STIMULATION OF ANTIBODIES: THE EFFECT OF MANGANESE ON AGGLUTININS. E. S. HORGAN, Brit. J. Exper. Path. **6**:108, 1925.

Some investigators feel that the quantitative production of certain antibodies, especially antitoxin, can be increased by the injection of various metallic salts into the immunized animal. Manganese and beryllium have given the best results. There have been very conflicting reports concerning the influence of these metals on the production of other antibodies. The author studied the effects of the intravenous injection of manganese on the formation of typhoid agglutinins in rabbits. In none of the animals did the injections of inorganic

manganese prevent the fall in agglutinating titer from its original high point produced by the injection of typhoid bacilli. Three out of six animals showed a slight secondary rise in titer when the manganese was given subsequently to this postapex fall. A commercial preparation of manganese cleaned in colloidal form gave entirely negative results. The author suggests that the reaction to the nonspecific stimulation of the manganese depends more on the antibody potentialities of the animal than on the chemical.

THE ANTIGENIC PROPERTIES OF PRECIPITATES PRODUCED BY THE INTERACTION OF DIPHTHERIA TOXIN AND ANTITOXIN. PERCIVAL HARTLEY, Brit. J. Exper. Path. **6**:112, 1925.

The diphtheria toxin-antitoxin mixtures commonly used for the production of active immunity cause some local reactions because of the contained nonspecific poisonous substances from culture mediums, horse serum and bacterial protein. It is possible to secure an antigenic flocculent precipitate almost entirely free from these interfering substances when diphtheria toxin and antitoxin are mixed under proper conditions, as outlined by Ramon. This precipitate is toxic, neutral or antitoxic depending on whether it was precipitated from an underneutralized, exactly neutralized or overneutralized mixture. The substance is insoluble in saline and can have nearly all the contaminating material removed by repeated washing in this fluid. Guinea-pigs injected with the washed precipitates from overneutralized mixtures developed an immunity to diphtheria toxin and had demonstrable antitoxin in their blood. The antigenic power of the flocculent precipitate varied inversely with the amount of antitoxin present in the mixture from which the precipitation occurred. The most active preparation was obtained from a mixture which was slightly toxic for guinea-pigs.

HOAG, New York.

LATE STIGMAS OF PREMATURITY. JOSÉ ESTELLA B. DE CASTRO, Arch. españ. de pediat. **8**:579, 1924.

Independent of immediate manifestations occurring at birth, the premature infant can present in the course of its development a series of anomalies which combined constitute, as it were, a secondary syndrome of prematurity.

This syndrome is somewhat delayed in appearance and is characterized clinically by enlargement of the head. This may appear froglike; the tongue is large, and the eyes protrude. There is a characteristic adenoid habitus, or there may be a diminutive development—the type of the micromeliac with peculiarly diffuse fat deposits, voluminous genitals and fetal implantation of the umbilicus.

These peculiar changes or characteristics are not present at birth, but always appear about the second month of life and disappear spontaneously during the second or third year of childhood. They are of endogenous origin and are intimately associated with the degree of prematurity, which is the sole cause for the appearance of this peculiar syndrome.

The author believes that endocrine deficiency is a big factor and that thyroid and hypophysis hormones are principally involved.

SCHLUTZ, Minneapolis.

EXPERIENCES WITH THE SYPHILIS-MICROREACTION OF MEINICKE. ERICH LOEWY, Monatschr. f. Kinderh. **30**:300, 1925.

Loewy compared the results of the Meinicke syphilis reaction with the Wassermann reaction in 500 cases, and found that they agreed in 97 per cent. If this is confirmed, the reaction will be a very simple and rapid laboratory method for the diagnosis of syphilis.

GERSTLEY, Chicago.

UNILATERAL KIDNEY FUNCTION TEST WITH SODIUM IODID AND SODIUM THIOSULPHATE. W. NYIRI, Wien. arch. f. inn. med. **2**:511, 1925.

The author has revised and improved the older qualitative iodid test. The method can be carried out in approximately two hours.

A gram of sodium iodid is given intravenously and the first two-hour portion of urine following the administration is examined.

The iodin is determined quantitatively according to the process of H. Singer. This procedure can be carried out in a few minutes and gives results sufficiently accurate for clinical purposes. Excretion above 150 mg. is regarded as evidence of normal kidney function. The volume of excretion seems to run parallel to the severity of involvement of the kidney structure.

The sodium thiosulphate test can easily be combined with iodid test. This makes it possible to secure quantitative data on two separate kidney functions—one entirely independent of the other.

INVESTIGATION ON THE CHONDRODYSTROPHIC DWARF. JULIUS DONATH and ALFRED VOGL, Wien. Arch. f. inn. Med. **10**:1, 1925.

The vertebral column of the chondrodystrophic adult dwarf is never normal. Aside from the lumbosacral convexity, there are constant deformities in the dorsolumbar region. There is generally a dorsolumbar kyphosis. In a few cases an acute angular gibbus is observed in this region.

Kyphosis in this region is observed even in the full grown fetus.

The vertebrae in the dorsal and lumbar region always show changes from the normal, notably a convergence of the superior and inferior surfaces. This convergence takes particularly an anterior direction.

The cause of the deformity lies in diminished growth energy of the chondrodystrophic cartilage with the resulting inability to overcome physiologic stresses occurring in the natural processes of growth in this region.

SCHLUTZ, Minneapolis.

A SIMPLE METHOD FOR COUNTING BLOOD PLATELETS. J. BOROS and O. KALTSTEIN, Orvosi hetil. **69**:457, 1925.

The skin for pinprick has to be carefully cleansed with ether. On the wound a drop of isotanic solution of neutral sodium citrate is placed so that the blood mixes directly with the solution. After stirring the mixture of blood and citrate with a glass stick dipped into paraffin, a small drop of it is brought on a cover glass. This is placed on a slide, which has been prepared in the following way: it is carefully cleansed, a drop of concentrated alcoholic solution of brillant-cresyl-blue is placed on it, and evaporated over a flame. The dye will cover the slide in a fine thin film. If no dust or cotton fibers have got between the slide and cover, the blood will spread out very evenly. The cover glass is closed in with paraffin.

Counting is done with the use of an immersion system and in the usual way, based on the number of red blood cells.

THE INFLUENCE OF EPINEPHRIN AND ATROPHIN ON THE WHITE BLOOD COUNT OF INFANTS DURING DIGESTION. G. TÖRÖK, Orvosi hetil. **69**:480, 1925.

Subcutaneous injection of 0.5 mg. of epinephrin or atrophin to normal infants, who react to ingestion of food with leukopenia, changed the reaction into leukocytosis, if the injection was made simultaneously with the ingestion of food. In infants, whose normal reaction is leukocytosis, this reaction was increased by the injections.

After the injection of epinephrin twenty minutes before the ingestion of food, the results were not harmonious.

Atrophin injected before the ingestion of food caused a very conspicuous drop in the white blood cells, chiefly in cases reacting with alimentary leukopenia.

ZENTAY, St. Louis.

Nutrition

FAT SOLUBLE VITAMINS. XXIII. THE INDUCTION OF GROWTH-PROMOTING AND CALCIFYING PROPERTIES IN FATS AND THEIR UNSAPONIFIABLE CONSTITUENTS BY EXPOSURE TO LIGHT. H. STEENBOCK and ARCHIE BLACK, J. Biol. Chem. **64**:263, 1925.

Fats, especially the nonsaponifiable portions, have been found to develop antirachitic and growth producing properties following irradiation with ultraviolet light.

The optimum time of irradiation of olive oil and cod liver oil to produce maximum antirachitic power was from thirty minutes to five hours. Prolonged irradiation of from ten to seventeen hours destroyed this property. Pure cholesterol, however, did not lose its antirachitic property on prolonged irradiation.

Old oils, which had been in the laboratory for several years, did not develop antirachitic property on irradiation. The nonsaponifiable constituents (phytosterols) of these old oils were separated and found also to have little or no antirachitic property on irradiation. It does not seem to be the acidity of an old oil which causes this change. Mixing an old oil with fresh oil does not deprive the fresh oil of antirachitic activity.

Mineral oil on irradiation was not activated.

A thickness of water (140 mm.) was placed between an ultraviolet light and olive oil. The olive oil became antirachitic. This will perhaps explain how fish may receive the antirachitic property which is stored in their tissues.

THE EFFECT OF HEAT ON THE SOLUBILITY OF THE CALCIUM AND PHOSPHORUS COMPOUNDS IN MILK. RAYMOND W. BELL, J. Biol. Chem. **64**:391, 1925.

When milk is heated to temperatures below 170 F., the distribution of calcium and phosphates is essentially the same as in raw milk. If the milk is heated to temperatures over 170 F., some soluble calcium and phosphate are precipitated; this amounts to about 10 per cent. of the amount in solution, when the milk is heated to boiling for thirty minutes.

FURTHER STUDIES ON THE PHYSIOLOGIC ACTION OF A PARATHYROID HORMONE. J. B. COLLIP and E. P. CLARK, J. Biol. Chem. **64**:485, 1925.

Collip and his associates have isolated an active preparation from the parathyroid gland of oxen (Abstr. Am. J. Dis. Child. **30**:259 [Aug.] 1925). This preparation when given to normal or parathyroidectomized dogs causes an increase in the calcium of the blood. Tetany has been relieved. Overdoses of the preparation cause a symptom complex called hypercalcemia.

In the present paper the authors described the method of assaying their preparation. The unit of potency of the parathyroid hormone is set at 1:100 of the amount which will produce an average increase of 5 mg. per hundred cubic centimeters blood serum over a period of fifteen hours in a dog weighing 20 kg.

No work on human subjects is described. Experimental work on dogs, especially as to overdosage of the hormone, is given in this paper.

HIGGINS, Cincinnati.

THE DIRECT ACTION OF INSULIN ON FAT METABOLISM. H. S. RAPER and E. C. SMITH, J. Physiol. **60**:41-48, 1925.

Insulin causes hypoglycemia in decerebrate cats from which the pituitary body has been removed only in animals with poor glycogen reserve. In decere-

brate animals with insulin hypoglycemia fat disappears from the liver to the extent of 10 per cent. of the initial fat content and concurrently increases in muscle to the extent of 10 per cent. It also increases in blood. These effects do not occur until the blood sugar concentration falls below 0.1 per cent. They appear to be associated only with the extreme effects produced by insulin. In decapitate eviscerate animals with constant infusion of glucose, no change in the fat content of muscle occurs under the action of insulin. The evidence obtained does not support the view that fat synthesis in the liver is associated with insulin hypoglycemia.

KUGELMASS, New York.

OBSERVATIONS ON GLUCOSE METABOLISM. C. H. HOFRICHTER, Northwest Med. **24**:271 (June) 1925.

Hofrichter outlines our present-day idea of the sugar metabolism, the derivation of glucose from the principle food elements, the effects of the administration of glucose on the blood sugar content in normal and abnormal states, the effects of excess or deficiency of the pancreatic hormone on the same, the variability of the renal threshold for sugar, and the rôle of the liver in the control of the blood sugar level.

STRICTURE OF THE RECTUM AS AN INDIRECT CAUSE OF PELLAGRA. T. M. JOYCE and DEAN B. SEABROOK, Northwest Med. **24**:285 (June) 1925.

Joyce and Seabrook's patient was a woman, aged 54, for years a sufferer with hemorrhoids. Seven years previously she had had an operation, but this had failed to give relief. For the past five years the patient had lived on a diet of toast, mush, coffee, tea, bread, butter, occasionally an egg or some milk, thinking that this diet would prevent irritation of the hemorrhoids. On account of the dietary inadequacy, the patient developed typical pellagra. Correction of the rectal condition failed to improve the pellagra. The authors comment on this point, and state that rapid progress of pellagra following operations has been noted by many writers.

SCOTT, Philadelphia.

THE BACTERIOCIDAL ACTION OF THE BLOOD IN CERTAIN DIETARY DEFICIENCIES. G. M. FINDLAY and IAN MACLEAN, Bioch. J. **19**:63-69, 1925.

The blood of normal rats, tested against *S. aureus* shows a killing power of about 70 per cent. Rats fed on a diet deficient in vitamin A and the antirachitic factor show a reduction in the bactericidal power of the blood only after the onset of keratomalacia or some other infection. In rats fed on a diet deficient in vitamin A and the antirachitic factor, but exposed to ultraviolet light, the onset of bacterial infection and the reduction in the bactericidal power of the blood are delayed. Rats suffering from keratomalacia as the result of a diet deficient in vitamin A continue to show a low bactericidal power of the blood after exposure to ultraviolet light. Rats fed on a diet lacking in phosphorus and the antirachitic factor show a reduction in bactericidal power of the blood. Rats fed on a diet lacking vitamin B show a reduction in the bactericidal power of the blood unassociated with bacterial infection but correlated with the fall in body temperature.

THE INFLUENCE OF DIFFERENT SUBSTANCES ON THE DIASTATIC ACTIVITY OF SALIVA. HILDA WALKER, Biochem. J. **19**:221-225, 1925.

Cane sugar and saccharin in the mouth have the most marked effect in producing a very active saliva. In the case of cane sugar this is largely due to its stimulating action on the ptyalin. Maltose increases the quantity of ptyalin produced but depresses the activity of the enzyme. Lactose inhibits the production of ptyalin but enhances its activity. Glucose and fructose decrease the activity of saliva.

A Comparison of Dried and Evaporated Milks by a Dietetic Method. Gladys A. Hartwell, Biochem. J. **19**:226-232, 1925.

The vitamin B content of evaporated milk is lower than that of dried and fresh milks. Dried milks vary in their vitamin B content independent of the milk or manufacturer. Dried skim and half-cream milks are not quite so good as the same makes in full cream.

The Production of Acidosis by Injection of Magnesium Chlorid and Strontium Chlorid. John B. S. Haldane, Biochem. J. **19**:249-250, 1925.

The reaction occuring in the intestine is $MgCl_2 + 2NaOH \rightleftarrows NaCl + \downarrow Mg(OH)_2$, the insoluble hydroxid or carbonate being excreted rectally and the sodium chlorid reabsorbed. The net effect is the substitution of sodium bicarbonate by sodium chlorid in the blood and tissues just as if an equivalent of hydrochloric acid is taken. A certain amount of the bivalent metal would also be precipitated and excreted as soap with the same effect on the reaction of the tissues.

Kugelmass, New York.

Diet in Childhood. A. Dingwall Fordyce, Brit. J. Child. Dis. **22**:83 (April-June) 1925.

The article is divided into three sections, namely, 1. Baby Feeding. 2. Feeding of Healthy Children. 3. Diet in Some Conditions of Illness.

Under the first heading the author takes up the normal food, caloric, and vitamin requirements of healthy babies as well as the treatment of the primary digestive disturbances. He advises that the milk always be scalded and that until 5 years old the child should never drink unboiled milk, nor should he have cream, junket or cream cakes.

He considers that for the healthy child of any age the only practical standard for the amount of food must be the child's appetite and common sense on the part of the attendant.

In the case of the "Cripple Child" (that is, a child debarred through deformity or disease from obtaining the natural amount of exercise), the factors going to determine the optimum diet are varied and complex and peculiar to each individual case. Total immobility by itself almost halves the food requirements.

In tuberculous children, as shown by Pirquet and others, the desideratum is a well balanced diet. Though unlike many cases in adults their power of digesting fat is often good, nevertheless this power must not be strained.

Generally speaking, the "Cripple Child's" food should approximate in ratio that of the healthy child of the same age and the quantity should be primarily guided by the appetite.

Langmann, New York.

The Production of Cataracts in Young Rats by Vitamin Poor Diets. A. V. Szily and A. Eckstein, Klin. Wchnschr. **4**:919, 1925.

With a modification of McCollum and Simonds diet No. 3143, these investigators claim to have produced cataracts in young rats. It is still undetermined whether this effect is due to the inadequate diet from the quantitative standpoint or whether it is due to the absence of a specific vitamin which they have named "Factor Z."

Treatment of Rickets with Milk Exposed to Ultraviolet Ray. P. György, Klin. Wchnschr. **4**:1118, 1925.

Following suggestion of the work done by Hess and by Steenbock and Black, György exposed milk for one-half to one hour to ultraviolet lamp, and used the product in the treatment of rickets. Sixteen out of eighteen patients with

florid rickets responded to the treatment. Some of these had tetany. All the diagnoses were controlled by radiologic as well as serum calcium and phosphorus determinations. All other treatment was omitted during the experiment. All patients responded in from four to six weeks—some in fourteen days. By the so-called "jecorisation" (cod liver oil—oleum jecoris aselli), the milk takes on qualities which have a beneficial influence on the metabolism of rickets.

THE VITAMIN C CONTENT OF MILK. A. FRANK, Klin. Wchnschr. **4**:1205, 1925.

This author found that milk does not contain as much vitamin C as is generally assumed. He regards the type of feeding the cows receive, particularly during the winter, of greatest importance. Hydrogen peroxid must not be used in preservation of milk. Prolonged pasteurization is warned against. The guinea-pig is so susceptible to scurvy that Frank doubts whether it is a suitable animal for testing antiscorbutic factors. Even those in whom breast milk was used as the antiscorbutic developed the disease.

THE BEST METHOD OF CALCIUM ADMINISTRATION AND INDICATIONS FOR ITS USE. ARTHUR SCHLOSSMAN, Klin. Wchnschr. **4**:1262, 1925.

Calcium chlorid has been most generally advised when an appreciable dosage of calcium was indicated. This is rather difficult to give to children, particularly if needed for any period of time. Schlossman has had a preparation of calcium citrate manufactured to take its place. He found that serum calcium determinations showed an increase after its use equivalent to that after calcium chlorid. It is easily given to children. Besides the more common indications for calcium therapy—rickets, chronic eczema, hemorrhages, asthma and spasmophilia—Schlossman suggests its possible advantage in bronchial gland tuberculosis. He regards it as theoretically possible that calcification would more easily take place given a higher concentration of blood calcium.

SCHWARTZ, Milwaukee.

THE EFFECT OF VARIOUS MONO AND DI SACCHARIDES UPON THE HYDROCHLORIC ACID SECRETION OF THE STOMACH. PAUL MAHLER, Wien. Arch. f. inn. Med. **10**:549, 1925.

Cane sugar in 5 per cent. solution strongly stimulates hydrochloric acid secretion in persons who react strongly with gastric secretion on the ingestion of food. In those who in this respect react weakly, the sugar solution also acts as a feeble stimulant. It hardly exceeds the effect of plain water.

Sugar solutions of 20 per cent. uniformly have the effect of lowering hydrochloric acid secretion.

Various sugars differ in their effect. One group may be characterized as fairly strong stimulants of hydrochloric acid secretion; the other as fairly weak stimulants. To the former belong galactose, glucose, maltose; to the latter, lactose, levulose and arabinose. The effect of saccharose lies between these two and is subject to the greatest variations.

The chemical constitution of the sugar seems to be the determining element in its effect on gastric hydrochloric acid secretion.

SCHLUTZ, Minneapolis.

Prenatal Conditions

CONGENITAL DEBILITY. A. B. MARFAN, Nourrisson **13**:100 (March), ibid., 141 (May), 1925.

The three important signs of congenital debility are: (1) subnormal weight, (2) diminished body length and (3) imperfect function of the vital organs. A weight a little under 3,000 gm. is always suspicious and suggests a slight or

first degree debility; between 2,500 and 2,000 gm., second degree debility, and below 2,000 gm., a severe or third degree debility. The body length is also an important index, varying from 47 to 35 cm. It is important to remember that the relationship between body weight and body length is not always proportional. Body length is a much more accurate index of the degree of prematurity than is the weight. The following table is given:

Age of Fetus, Months	Weight, Gm.	Length, Cm.
5	400	25
6	1,000	30
7	1,700	35
8	2,400	44
9	3,250	49

Congenital debility is frequently associated with prematurity. Congenital malformations are common; the skin and internal organs are poorly developed, subnormal temperatures are usually present and there is a marked predisposition to infection. From an etiologic standpoint, congenital debility may be classified as simple or pathologic. The common causes of the latter are tuberculosis, alcoholism in the parents and congenital syphilis. The prognosis is always grave. Of 222 patients weighing less than 2,500 gm., 80 per cent. died during the first month. In those surviving, Little's disease is a common sequela.

McCLELLAND, Cleveland.

Diseases of the New-Born

HEMORRHAGE IN EARLY INFANCY. C. F. T. EAST, F. COVE-SMITH and F. O. T. STRANGE, Brit. J. Child Dis. **22**:128 (April-June) 1925.

The authors cite three cases which they studied. The first, a female infant, aged 14 days, was admitted in a critical condition with bleeding from the vagina and rectum and died nine hours after admission. At necropsy, evidences of hemorrhage were found under the pleura on the left half of the diaphragm, in the peritoneal cavity and in and around the liver and the uterus. The case gave the impression of being one of melena neonatorum, but all the blood probably came from the uterus. In the opinion of the authors it was a case of severe hemorrhagic disease, of which the hemorrhages in the genital tract were the only symptoms.

The second case, that of a girl, who died on the second day of life, is presented as one of true melena neonatorum. The blood came from an ulcer in the first part of the duodenum.

The third patient, a boy, aged 6 weeks, was operated on as intussusception was strongly suspected; he died soon after operation. No intussusception was found but a condition such as may be found in Henoch's purpura, that is, tendency to spontaneous hemorrhage into the coats of the intestine and also behind the peritoneum and into the lung. There was also abnormal bleeding from the operative wound.

"It is very unusual to find Henoch's purpura so early in life and its occurrence would appear to link up the purpuras of later life with cases of hemorrhagic disease of the new-born.

LANGMANN, New York.

THE BLOOD AND BONE MARROW IN PREMATURE INFANTS. R. POLITZER. Pediatria **33**:83, 1925.

Politzer found in the bone marrow of premature infants a prevalence of immature red cells and in many cases an eosinophilia. In about 50 per cent. of the cases, the blood of premature infants contains large numbers of erythroblasts and few immature white cells. Whenever, in bone marrow, there are found three times as many reds as whites, then the erythroblasts are passed into the blood stream in large numbers.

DESANCTIS, New York.

Acute Infections

ACTINOMYCOSIS OF THE KIDNEY. ALEXANDER H. PEACOCK, Northwest. Med. **24**:173 (April) 1925.

Peacock reports actinomycosis of the kidney in a boy, aged 8, fed on the milk of a cow with an abscessed jaw. After a prolonged febrile period, the boy developed an abscess in the right loin, which when filled with bismuth and roentgenographed showed a large spider-like cavity. Cystoscopy showed a right ureter which could not be catheterized. Nephrectomy was performed and a number of sinuses excised. The boy died twelve days later following the development of a fistulous opening between the duodenum and the wound. Several large paravertebral abscesses, an abscess of the liver and a small abscess of the left kidney were found at necropsy. Differentiation from tuberculosis was only made by microscopic section, the symptoms being the same.

SCOTT, Philadelphia.

FURTHER OBSERVATIONS OF VIRULENT DIPHTHERIA BACILLI IN FOWLS. W. LITTERER, South. M. J. **18**:577, 1925.

The author investigated 256 cases in which virulent Klebs-Loeffler bacilli (acute or carrier) existed in a family which owned fowls suffering with some form of ailment such as roup, fowl diphtheria or cholera.

Culturally, tinctorially and by virulence tests, the Klebs-Loeffler bacilli isolated from the fowls corresponded identically to the diphtheria bacilli isolated from each child in the families owning the fowls.

Successful inoculation of the virulent Klebs-Loeffler bacilli isolated from the fowls were produced in other fowls suffering with roup, and these experimental fowls were later cured by the administration of diphtheria antitoxin. Likewise, the virulent Klebs-Loeffler bacilli isolated from the children were successfully inoculated into fowls suffering with roup, and these experimental fowls were subsequently protected by diphtheria antitoxin.

In one instance it was evident that the fowls harbored virulent Klebs-Loeffler bacilli at least two weeks before the appearance of diphtheria in the family owning the fowls.

The author concludes from his investigations that fowls can transmit virulent diphtheria bacilli to the human being.

SCHLUTZ, Minneapolis.

THE VIRUS OF ENCEPHALITIS LETHARGICA. J. R. PERDRAU, Brit. J. Exper. Path. **6**:112, 1925.

Suspensions of brain tissue from patients dying as a result of clinical encephalitis have frequently been injected intracerebrally in rabbits in an attempt to isolate a specific virus. These attempts have often met with discouraging results. The author of this article recently reported the successful passage of herpes virus by intracerebral injections in rabbits which had been previously immunized against this virus, but in which the immunity had lapsed. He feels that during or after this temporary period of immunity a substance is formed which assists in the later successful implantation of the virus. He designates the substance as "aggressin."

A similar technic was applied to the study of brain material from three fatal human cases of encephalitis, and from each was isolated a virus which could not be distinguished in its neurotropic properties from the herpes virus described in his previous paper. It was proved that the "aggressin" is not the virus itself.

HOAG, New York.

THE TREATMENT OF TUBERCULOUS ANIMALS WITH A METHYL ALCOHOL EXTRACT OF TUBERCLE BACILLI. L. NÈGRE and A. BOQUET, Ann. de l'Inst. Pasteur **39**:101, 1925.

The subcutaneous injection of a methyl alcohol extract of tubercle bacilli into guinea-pigs and rabbits infected with virulent tubercle bacilli influenced the course of the disease favorably. The best results were secured when the bacilli were treated with acetone before they were extracted with methyl alcohol. Extracts made with acetone alone had a deleterious effect on the tuberculous animals. This is a preliminary report.

SPECIFIC ACTION OF ARSENIC (STOVARSOL) ON PLASMODIUM VIVAX. E. MARCHOUX, Ann. de l'Inst. Pasteur **39**:197, 1925.

The arsenical compound stovarsol in single doses caused rapid disappearance of the *Plasmodium vivax* from the circulating blood, but did not affect *P. malariae* or *P. falciparum*. Within two months of the time of treatment one third of the cases showed a relapse.

HOAG, New York.

EUPHORIA DUE TO FEVER. E. WEILL and P. BERTOYLE, Nourrisson **13**:115 (March) 1925.

The presence of fever is commonly associated with a train of unpleasant symptoms. However, in certain infections in infants between 1 and 2 years of age the contrary is true, and the authors consider this a favorable prognostic sign, especially in certain pneumonias, fevers of obscure origin, tuberculosis of the glands and in gastro-intestinal disturbances. When the temperature is elevated these infants become more playful, take their food better and seem quite happy. In these cases a remittent type of fever is present. Four illustrative cases are reported.

MCCLELLAND, Cleveland.

THE TREATMENT OF PERTUSSIS BY THE METHOD OF AUDRAIN. RAMÓN GIMÉNEZ GUINEA, Arch. españ. de pediat. **8**:605, 1924.

The author reports 302 cases of pertussis treated by the injection of ether according to the method advocated by G. Audrain in 1914. Of this series 250 were definitely cured, thirty-five were much improved, and seventeen were not relieved.

The severity and intensity of the paroxysm is lessened rapidly and the attacks are decidedly shortened. The vomiting often ceases after the first or second injection.

The author has never encountered local or general ill effect from the injections. The duration of the attacks is much shortened; a complete cure is often effected with eight or ten injections.

Complications such as bronchopneumonia seem to be infrequent under this form of treatment.

The injections of ether are generally given on alternate days but in cases of great severity or those complicated by bronchopneumonia, daily injections can be given, and in infants over 1 year the dose can range from 3 to 5 c.c.

THE ABDOMINAL SYNDROME IN ACUTE BRONCHOPATHIES OF THE NURSLING AND ITS PROGNOSTIC VALUE. A. ARGÜELLES TERÁN, Arch. españ. de pediat. **8**:735, 1924.

A grave abdominal syndrome accompanied particularly by tympanitis is sometimes observed in grave bronchopneumonias of nurslings.

The tympanitis develops acutely and rapidly with intense meteorism. There is constipation. The liver volume is increased and collateral venous circulation develops. Dyspnea becomes pronounced.

The brusque appearance of this syndrome in the course of grave pulmonary infection can easily simulate an obstruction or invagination or other grave abdominal condition, and can present a serious problem of differential diagnosis.

There is a passive congestion of the venous circulation in the walls of the intestine. This hyperemia through its effect on the terminal splanchnic nerves may cause a state of intestinal paralysis with resulting retention of gases and fecal material.

THIRTY-SIX CASES OF LARYNGEAL STENOSIS FOLLOWING MEASLES. JOSÉ MUÑOZ SECA, Arch. españ. de Pediat. **9**:330, 1925.

The author is of the opinion that measles definitely predisposes to diphtheritic infection. Localization in the larynx seems to be a selective characteristic.

Measles cases which give a positive Schick reaction should be immunized. The bacterial flora of the nasopharynx of children affected with measles should be examined as early as possible and they should be immunized against diphtheria germ carriers. The measles patient must be guarded against the diphtheria carrier by proper isolation.

Laryngeal stenosis following measles requires massive doses of antidiphtheritic serum. Not a moment must be lost and it must be given through the most rapid channels. The laboratory diagnosis must determine whether the laryngeal stenosis is diphtheritic or nondiphtheritic.

Intensive serologic therapy, the use of antispasmodic remedies, and hydrotherapy often are effective and obviate the necessity of intubation or tracheotomy. Both intubation and tracheotomy are procedures which should be delayed as long as possible in laryngeal stenosis following measles. Intubation generally gives poor results in these cases.

The author pleads for a vigorous campaign of antidiphtheritic immunization. Every child should have it.

SCHLUTZ, Minneapolis.

HERPES IN MENINGOCOCCUS MENINGITIS. P. GYÖRGY, Klin. Wchnschr. **4**:916, 1925.

In a child with the usual symptoms of meningitis, György noted that coincident with the appearance of herpes, the severity of symptoms was noticeably diminished. On the seventh day, the herpes began to dry up, whereupon the meningeal symptoms were more pronounced. Meningococci could not be demonstrated in the herpetic fluid. The subdural inoculation of dogs yielded the specific herpes which has been described by several investigators.

SCHWARTZ, Milwaukee.

TUBERCULOSIS SEPSIS. RUDOLF BÁLINT, Wien. Arch. f. inn. Med. **10**:165, 1925.

Tuberculosis sepsis occurs in various forms. Differences are determined partly by the massiveness of the infection, partly by the degree of general immunity or individual tissue immunity of the organism.

Generalization of mild infections occurs in juvenile tuberculosis. Generalization of the severest infections occurs in the form of generalized miliary tuberculosis and the fulminating so-called typhotuberculosis. There are many transitional stages between the mild and the severe forms. Clinical differences between these various forms depend on the intensity of the general septic symptoms. The anatomic difference consists in the appearance or nonappearance of miliary tubercles.

The intensity of the infection and the degree of the general immunity determines the clinical differences, while the anatomic differences are determined by the individual tissue immunity.

SCHLUTZ, Minneapolis.

TREATMENT OF TYPHOID FEVER WITH THE VACCINES OF CARONIA. E. TÜDÖS, Orvosi hetil. **69**:533, 1925.

Original vaccine of Caronia was used in intravenous injections. The results seem to be rather encouraging, as seen in the clinical picture of the cases treated. The white blood count increases, the agglutinating titer of the blood goes up, the fever decreases rapidly and the toxic symptoms disappear.

The method is recommended as a specific treatment in severe cases of typhoid fever.

ZENTAY, St. Louis.

Chronic Infections

SYPHILIS IN THE THIRD GENERATION. G. DETONI, Clin. Pediat. **4**:289-303, 1925.

The author reports six illustrative cases of congenital syphilis transmitted to the third generation.

Manifestations in these cases are chiefly endocrine disorders and skeletal dystrophies. There are also extensive and limited malformations. Diagnosis is made on the clinical picture and history. Serologic tests for syphilis are usually negative. Treatment is of no avail excepting in mild cases.

ZAMBARANO, Washington, D. C.

THE TREATMENT OF CYSTOPYELITIS IN THE NURSLING BY AUTOGENOUS VACCINES. LEON VELASCO BLANCO, Arch. Am. de med. **1**:38, 1925.

A chronic pyelocystitis will often respond with satisfactory results to autogenous vaccines when other forms of treatment have failed. The treatment is particularly indicated in severe cases and in those tending to relapse.

It can be used in addition to other forms of treatment and is seldom followed by untoward result.

There may be high temperature reactions following the use of the vaccines but these have no ill consequences and rapidly subside.

SCHLUTZ, Minneapolis.

TREATMENT OF PYELOCYSTITIS WITH AUTOVACCINES. Z. BÓKAY, Orvosi hetil. **69**:451, 1925.

The treatment of pyelocystitis with specific autovaccines, prepared from cultures of bacteria found in the urine, seems to be successful.

The effect of the treatment depends on the amount of bacteria used for subcutaneous injections. Results may only be expected if the injections are followed by strong general reactions. The dose required for this has to be determined by several experiments and if it has been found the treatment can be continued with increasing amounts. This form of treatment shows results in short time (from eight to ten days).

The dangers of the method are not excessive. The general reactions do not last long; the local reactions are painful and last for a rather long time. Often the injections are followed by a more or less severe diarrhea, but they stop after discontinuation of the injections.

The treatment is recommended for all cases in which other methods fail. The use of concentrated and not too much weakened vaccines is emphasized.

ZENTAY, St. Louis.

Internal Diseases

SOME FUNDAMENTAL PRINCIPLES IN THE DIAGNOSIS AND TREATMENT OF DIABETES MELLITUS. LUTHER T. NELSON, Northwest Med. **24**:265 (June) 1925.

A good general article outlining the etiology, diagnosis and treatment of diabetes mellitus. Nelson discusses various conditions which show glycosuria, describes normal and abnormal blood sugar curves, and renal glycosuria. Under treatment he considers preventive measures, dietary management, the use of insulin and the treatment of coma. The various laboratory procedures used are described. This is an article for general practitioners and medical students.

SCOTT, Philadelphia.

CHRONIC PEPTIC ULCER IN CHILDREN. O. S. PROCTOR, Surg. Gynec & Obst. **41**:63 (July) 1925.

Chronic ulcer of the stomach or duodenum in children is rare. A review of the literature reveals only nineteen true and two doubtful cases. At the Mayo Clinic, from 1906 to 1924, out of 8,260 cases of peptic ulcer only three were in children. One, a boy, aged 14 years, gave a history of periodic attacks of epigastric pain for six years, bearing no definite relation to food taking, not affected by alkalis, but relieved by vomiting. There was definite tenderness over the duodenum. The fluoroscope revealed a lesion near the pylorus and at operation a chronic penetrating callus ulcer was excised and a posterior gastro-enterostomy done. The recovery was uneventful. The second was a boy, aged 13 years, who had periodic dull epigastric pain and vomiting at frequent intervals for four years, relieved by vomiting and alkalis. Roentgenogram revealed a pyloric obstruction, and at operation a thickened annular ulcer of the duodenum was found. The walls were plicated over the lesion and a posterior gastro-enterostomy performed. The recovery was good. The third was a boy, aged 2 years, who was first seen when acutely ill, with vomiting of blood and bloody stools. With transfusions and medical care he made a good recovery, but within six months suffered a similar attack after tonsillitis. Transfusion and proper diet again cured him, only to have the same picture again repeated. This time death occurred from pneumonia.

As in adults, the etiology of these chronic ulcers is unknown. It is possible that many different factors are involved in the production of acute ulcers (trauma, malnutrition, toxemia from burns, acute and chronic infections) and that a few of these become chronic ulcers. Practically all of them occur near the pylorus, on the lesser curvature of the stomach or the anterior wall of the duodenum. About one third of the reported cases are associated with obstruction and a similar percentage have perforated, producing in all cases a general peritonitis. The onset of symptoms may be sudden, from hemorrhage or perforation, but, as a rule, there is a history of periodic attacks of epigastric distress recurring after meals, and usually relieved by food, alkalis or vomiting. Loss of appetite is the rule and as time goes on loss of weight and strength. The diagnosis should be made more often than it is, if one will but take into account the foregoing symptoms and check them up with examination of the stools and the roentgen ray. Medical management in all cases is advisable unless one is dealing with obstruction, perforation or a severe hemorrhage. In a review of 1,000 cases of gastric ulcer, sixteen gave a history of symptoms since childhood, and in 1,000 cases of duodenal ulcer twenty-six had a history of symptoms from childbirth. This is rather conclusive evidence that there may be many more chronic ulcers in children than we suspect, and the pediatricians should constantly be on the lookout for them.

MILLER, Chicago.

HEMATOPOETIC ORGANS IN SECONDARY ANEMIA. R. POLLITZER, Pediatria **33**:453, 1925.

Pollitzer's conclusions are: 1. The histologic changes of the bone marrow in anemic children depend on the etiology rather than on the intensity of the anemia. 2. In anemia due to suppurative processes, malnutrition or tuberculosis, the immature white cells of the bone marrow are present in three times larger amounts than the nucleated red cells. 3. In anemia due to syphilis, malaria or leishmaniasis, the number of erythroblasts is equal to or greater than the number of immature white cells. 4. In pernicious anemia the percentage of embryonal megaloblasts is high.

DESANCTIS, New York.

RECURRING NAVEL COLIC IN CHILDREN—A HYPATOSIS. FELIX PIELSTICKER, Monatschr. f. Kinderh. **30**:367, 1925.

Pediatricians have long noted the symptom complex called "recurring navel colic" in children. There has been much discussion as to whether it is a form of chronic appendicitis. The surgeons are of this idea and quote patients operated on successfully in whom an inflamed appendix has been found. Medical men call attention to the fact that in many of the patients operated on, the appendix has been found normal.

The author attempts to reconcile the two views by describing an epidemic of an acute nonsurgical liver disease which he witnessed some years ago. In this disease the symptoms were identical to the colic found in children, with pain typically in the region of the umbilicus . He formulates the theory that colic in children is due to some sort of temporary liver disorder of an epidemic nature.

GERSTLEY, Chicago.

Nervous Diseases

EXPERIMENTAL INVESTIGATION OF HERPETIC LESION DESCRIBED BY GYÖRGY AND ITS RELATIONSHIP TO HERPES ENCEPHALITIS. G. STEINER, Klin. Wchnschr. **4**:917, 1925.

Steiner maintains that herpes encephalitis as produced experimentally in dogs is a distinct entity that has no relationship to spontaneous encephalitis, or the encephalitis following injections of various toxins or irritants. It presents a histopathology that identifies it from these. Equally characteristic is the clinical picture developed by dogs injected. A detailed description of the histologic picture in the instance of herpes encephalitis produced by injection of the material from György's case is presented.

ENCEPHALITIS LETHARGICA AND DOG DISTEMPER. F. H. LEVY and R. KANTOROVICZ, Klin. Wchnschr. **4**:1254, 1925.

In 1921, these investigators reported the finding of a protozoan in the brains of 20 per cent. of dogs dying from distemper. Experiments at transmitting the disease were unsuccessful. Since von Kling's description of an organism found in human encephalitis, the description of which showed resemblance to that described by these authors, experiments were renewed. They were able to reinfect dogs with distemper, using material obtained from the brain of dogs that had died from the disease. Repeating similar experiments with encephalitis virus obtained from von Kling, the clinical picture of the two was so similar as to be indistinguishable and regarded by distemper by a veterinarian unaware of the experiment.

In three series they were unable to reinfect animals with the one virus that had previously been infected with the other virus, thus suggesting a reciprocal immunity.

This fact, plus the apparent resemblance of the organisms and the similarity in the clinical picture, suggests the identity or relationship of these two infectious agents.

CONTRIBUTION TO FEER'S RECENTLY DESCRIBED VEGETATIVE NEUROSIS IN CHILDHOOD (ACRODYNIA). W. KELLER, Klin. Wchnschr. **4**:1256, 1925.

A case report is given in great detail of a child, aged 3 years, presenting symptoms very reminiscent of acrodynia as described in this country. Characteristic of vegetative nervous system disturbance were the increased perspiration, increased blood pressure findings, tachycardia, and cyanosis of hands and feet. There were, however, symptoms representative of both vagus and sympathetic nervous system reactions. Keller is not certain of the identity of the picture with that described in this country as acrodynia.

SCHWARTZ, Milwaukee.

Diseases of the Ear, Nose and Throat

OBSERVATIONS OF ONE HUNDRED AND ONE CASES OF NASAL INFECTION, EXCLUSIVE OF DIPHTHERIA, IN CHILDREN. WILLIAM A. KRIEGER, New York State J. Med. **25**:203 (Feb. 13) 1925.

Study of the anatomy and histology of the nose, nasal mucosa and paranasal sinuses, with special reference to the lymphatic supply, readily accounts for the fact that nasal infection in childhood constitutes a paramount problem. For the expression, "catarrhal conditions associated with adenoids" should be substituted "adenoids or lymphatic hypertrophy associated with nasal infections." Tonsil and adenoid removal is not to be regarded as a cure for nasal and sinus infection.

Careful nasal examination is indicated in the case of a child who has fever, cough, enlarged glands or irritability. In twenty-one cases of the series, cough was prominent; in thirty-eight, fever, and in eighteen, enlarged cervical glands which returned to normal under nasal treatment. In nine cases malnutrition was marked; and in six, eye symptoms, the headaches and ocular disorders were of nasal origin conforming to Sluder's description. Nine patients exhibited asthma of a type classified under vasomotor rhinitis.

Treatment of nasal infection by suction is most important. After thorough cleansing, an application of protargin mild, either the silvol brand 10 to 15 per cent., or argyrol brand 25 per cent., is employed. In severe sluggish cases, or very acute cases, iodin is of benefit. Home treatment calls for saline nasal irrigations followed by instillation of chloramin-T 0.25 per cent. or a bland oil spray. Important adjuvants are sunshine, iron, arsenic and cod liver oil.

GRAVES, New York.

SURGERY OF THE TONSIL. J. I. MERSHON, Northwest Med. **24**:184 (April) 1925.

Mershon pleads for more deliberate and more careful tonsillectomy, with particular attention to hemostasis and to sparing surrounding structures. He uses the Sluder guillotine and gets good exposure of the anatomic parts by passing catheters through the nose and the nasopharynx, then out through the mouth; he uses these as retractors. He pays particular attention to each bleeding point.

ACTINOMYCOSIS OF THE NASOPHARYNX AND SOFT PALATE. G. W. MONTGOMERY, Northwest Med. **24**:344 (July) 1925.

Montgomery's patient was a girl, aged 12. Swelling of the submaxillary nodes of the left side was the first manifestation. These subsided but again swelled four months later. Tuberculosis was suspected because the mother had a history of tuberculosis three years before. A small yellow nodule was found on the soft palate and one on the posterior pharyngeal wall. Ray fungus was obtained from the first. After local cauterization with copper sulphat-

and saturation of the system with potassium iodid, the nodes were completely healed and the patient's physical condition improved. Montgomery gives a guarded prognosis, fearing the development of gastro-intestinal or renal infection.

SCOTT, Philadelphia.

SOME UNUSUAL SEQUELAE OF TUBERCULOUS TRACHEOBRONCHIAL ADENITIS IN CHILDREN. J. M. SMELLIE, Brit. J. Child. Dis. **22**:110 (April-June) 1925.

By far the most frequent dangerous complication of tuberculous adenitis in the tracheobronchial region is rupture of the caseous gland into one of the thin walled blood vessels. The esophagus, the trachea and bronchi and the pericardium, being thicker structures, can obviously offer increased resistance and are rarely involved in the suppurative process.

The author records two cases of esophageal perforation, two cases of esophageal diverticula, four cases of bronchial perforation and one case of pericardial perforation, all resulting from caseation of the mediastinal glands.

LANGMANN, New York.

CHRONIC STRIDORS IN INFANTS. A. B. MARFAN, P. VALLERY-RADOT and J. DELRAY, Nourrisson **13**:26-43 (Jan.) 1925.

Stridors may have their origin in the larynx, trachea or in a large bronchus. The common types are discussed, especial emphasis being placed on those produced by compression of the trachea or a large bronchus by enlarged tuberculous glands. A case is reported by the authors which seemed to fall into this category, except that the enlarged glands were due to syphilis. Repeated tuberculin tests were negative, as was also the Wassermann reaction. Death occurred at 22 months from bronchopneumonia. Necropsy showed an enlarged hilum gland compressing the trachea, thus explaining the stridor.

Microscopic examination of the affected glands showed the vascular lesion characteristic of syphilis. The spleen weighed 40 gm., and was large and hard.

McCLELLAND, Cleveland.

HEMATOLOGIC RESEARCHES ON ADENOIDS. DONATO DI DONATO, Arch. ital. d. otol., rinol. e laringol. **36** 165-174, 1925.

As the result of his researches on the hematology of adenoids, di Donato reached these conclusions: In the presence of adenoids, the lymphoid tissues are constantly in a state of hyperplasia, as is shown by the evident mononucleosis and the frequent occurrence of undeveloped or only partially developed lymphocytes (lymphoblasts or prolymphocytes). Such irritation induces in high-grade adenoids also hyperplasia of the myeloid tissues in the erythrocytes and the leukocytes, as is revealed not only by the presence of normoblasts, which have been demonstrated by many authors, but also by the increase of granular red blood cells and by Arneth's formula, which showed a shifting to the left, or a predominance of younger forms. There is a marked azurophilia in adenoids, and, if we assume, as do most authors, that this is an expression of a toxic state, it is logical to conclude that such patients are suffering from a chronic toxic infection (syphilis, tuberculosis), as will be brought out in a later article. In patients in a highly weakened condition, these phenomena are lacking, which points thus to a state of hematopoietic energy, in which the myelolymphoid tissues remain inert toward the irritative cause and leave the organism undefended.

WOLCOTT, Chicago.

PSEUDOMEMBRANOUS OSTEITIS AND MASTOIDITIS SECONDARY TO A DIPHTHERITIC PHARYNGITIS. A. MARTIN CALDERIN, Arch. españ. de pediat. **2**:275, 1925.

The author reports the occurrence of this condition in a boy, aged 3 years. When first seen, the child presented extensive diphtheritic involvement of the fauces, tonsils, retropharynx and massive bilateral adenitis. Prostration was extreme.

With intensive treatment the more severe symptoms subsided temporarily. On the eleventh day the patient rapidly grew worse. There was a great deal of pain about the right ear. There was no suppuration but an exploratory operation revealed a classical mastoiditis. The tympanic membrane showed moderate inflammation.

Paracentesis was performed. The child's condition rapidly grew worse and a radical mastoid operation was performed. An extensive osteitis with necrosis was found. The entire cavity was filled with a pseudomembrane which proved to be diphtheritic. The cavity was packed with gauze saturated with antitoxin and a massive dose of antitoxin given intravenously. The child made an uneventful recovery.

SCHLUTZ, Minneapolis.

THE ORIGIN AND TREATMENT OF STRIDOR CONGENITUS. KARL BENJAMIN, Monatschr. f. Kinderh. **30**:242, 1925.

If these observations are confirmed they will be an interesting addition to our pediatric literature. Benjamin saw a patient, aged 5 months, who had had an inspiratory stridor since birth. The roentgenogram showed the shadow of an enlarged thymus. There was some difficulty in getting a satisfactory plate, however, and in order to quiet the child in preparation for another picture an anesthetic was ordered. As the anesthetist before administering the anesthetic pushed forward on the angle of the jaw, the stridor ceased. This procedure was repeated a number of times with the same result. The family physician insisted on roentgen-ray treatments, which were given; they had no immediate effect, but after several months the child did make a perfect recovery.

Benjamin has collected five such cases, all the patients acting in the identical manner, and being relieved by pressure forward on the lower jaw. In all, the stridor was inspiratory, was of a coarse nature not like that originating in the vocal coards, and disappeared on crying. He could feel vibrations in the angle between the chin and the neck and in one case could feel the vibrating epiglottis with his finger.

He submits diagrams showing the relatively higher position of the larynx of the infant than the adult. The relatively large tongue of the infant, as well as the short mouth cavity, aid in crowding the entrance to the larynx. The shortness of the lower jaw in some of these cases has already been noted by Finkelstein.

Benjamin believes that the usual stridor congenitus is due to the vibration and inspiratory drawing in of the upper border of the entrance to the larynx. The finding of an enlarged thymus is purely an incidental affair and not the true cause. Forward pressure on the lower jaw by relieving the laryngeal stridor is a valuable diagnostic procedure. The children all outgrow the trouble.

GERSTLEY, Chicago.

Diseases of the Skin

MALIGNANT PIGMENTED MOLE IN AN INFANT. HERBERT D. COE, Northwest Med. **24**:181 (April) 1925.

This child was born with two small wartlike growths in the hair of the parietal region, left side. These grew rapidly and coalesced at the age of 2 months. Shortly after this, a tender swelling appeared on the left side of the neck below the ear. The tumor was excised and part of the sternomastoid

attached thereto was removed. A number of pinhead-sized nodules were noticed in the surrounding tissues. Four weeks later a nodule was noticed in the right abominal wall, and a large mass in the left side of the abdomen, and several tumors about the head and neck. The child lived for two months after the operation. Microscopic section of the excised tumor was malignant pigmented mole.

SCOTT, Philadelphia.

A FURTHER NOTE ON ERYTHEMA NODOSUM. F. PARKES WEBER, Brit. J. Child Dis. **22**:33 (April-June) 1925.

That erythema nodosum is occasionally due to a tuberculous bacillemia the author considers practically proved, as well as that other microbic septicemias may also at times give rise to it, such as occur in rheumatic fever, tonsillitis, and various infectious diseases.

In particular individuals (particular "soils"), it seems probable that absorption of toxins from the alimentary canal may set up an attack of erythema nodosum, and in some even drugs, that is, potassium bromid, may give rise to an attack.

LANGMANN, New York.

THE LIGHT PROTECTIVE POWER OF TANNIN. P. S. MEYER and S. AMSTEN, Klin. Wchnschr. **4**:923, 1925.

In persons presenting idiosyncrasy to light, the type of sensitiveness that reacts by various skin eruptions, it was found that tannin in 10 per cent. alcoholic solution or in petrolatum gave protection. This protection is explained on the basis of colloid chemical changes in skin structure.

SCHWARTZ, Milwaukee.

NEVI IN CHILDHOOD. ERICH LOEWY, Monatschr. f. Kinderh. **30**:304, 1925.

This is a clinical study of 400 children, showing that by the time they were of school age almost all had some sort of pigmented nevus. There was no relation of the occurrence of the nevus to pigment of the eyes or hair or to any other anomaly of the skin.

GERSTLEY, Chicago.

ON "EXANTHEMA SUBITUM" IN CONNECTION OF ELEVEN CASES. J. BÓKAY, Orvosi hetil. **69**:585, 1925.

In eleven patients, all under 2 years of age, the same clinical picture of the disease as first described by American authors was observed.

Bókay thinks that the disease is a definite entity, with undoubtedly infectious origin, but of little contagiousness.

ZENTAY, St. Louis.

Surgery and Orthopedics

REPORT OF A CASE OF KOHLER'S DISEASE AND DISCUSSION. DONALD A. MURRAY, Northwest Med. **24**:180 (April) 1925.

Murray's patient was a boy, aged 5, complaining of pain and limping after donning lighter weight shoes. He showed tenderness over the tarsal navicular. A roentgenogram showed Kohler's disease to be present. Murray reviews the symptoms, diagnosis, etiology and treatment. He inclines toward the traumatic theory of development.

TREATMENT OF TUBERCULOSIS OF THE SPINE ON THE BENT BRADFORD FRAME. H. J. WYCKOFF, Northwest Med. **24**:227 (April) 1925.

The writer reports five patients satisfactorily treated by hyperextending the spine over an angulated frame.

Society Transactions

AMERICAN PEDIATRIC SOCIETY

Thirty-Seventh Annual Meeting, held in Washington, D. C., May 5-7, 1925

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THIRD SESSION

FURTHER OBSERVATIONS CONCERNING THE NATURE OF NUTRITIONAL DISTURBANCES. Presented by DR. MCKIM MARRIOTT.

Nutritional disturbances due to dietary faults are now fairly well understood and may be satisfactorily treated. Such disturbances are usually the result of diets deficient either quantitatively or qualitatively. The theory of food or alimentary "intoxication" fails in many particulars to provide a satisfactory explanation for the disturbances. That enteral and parenteral infection may result in nutritional disturbances has been recognized for many years. The purpose of this paper is to point out the apparent etiologic relationship between infections of a special type and the severe nutritional disturbances characterized by severe watery diarrhea, prostration, rapid loss of weight, failure to retain fluid, even when given in large amounts, a gray color of the skin and acidosis.

Complete necropsies on a number of infants suffering from this type of disturbance revealed streptococcus infections of the mastoid antrum. Similar observations have been made by Renaud (*Bull. et. mém. Soc. méd. d. hôp. de Paris* **45**:1326, 1921), Byfield (*Abt's Pediatrics* **3**:786, 1924), and Floyd (*Arch Otolaryngol.* **1**:411, 1925). In a group of twenty infants suffering from the symptoms described, mastoid antrums were opened under local anesthesia and streptococcus pus was obtained. The operation itself caused little disturbance. In a large proportion of the cases there was almost immediate relief of the symptoms. The usual local signs of mastoid involvement such as swelling, redness and tenderness were absent. The tympanic membrane showed some change in all cases and there was a consistent sagging of the posterior superior wall of the canal near the junction with the tympanic membrane. It is possible that a mastoid antrum infection can clear up without operation, but in many young infants there is excessive folding of the embryonic mucosa in the attic, which in the presence of infection swells so as to completely close off the attic and antrum. In other instances the *aditus ad antrum* is so narrow at its posterior end that adequate drainage is not possible. In this way infections remain active in the mastoid antrum, despite free paracentesis.

Infections of the mastoid antrum, with organisms other than streptococcus, do not give rise to the same general symptoms. It is suggested that the streptococcus toxin exerts a specific action on the capillaries of the body in general and of the intestinal tract in particular, which results in the hydrolability which is so characteristic.

The most successful dietary treatment has been a high caloric diet of undiluted lactic acid milk with the addition of fair amounts of corn syrup. Any considerable restriction of the diet is to be avoided.

The early cases in this series were operated on by Dr. Harry W. Lyman and Dr. M. F. Arbuckle. The technic was further perfected by Dr. Arthur M. Alden, who operated on the last fourteen of these patients.

DISCUSSION

DR. JEANS: During the last winter I have seen several cases similar to those Dr. Marriott has described. The striking feature is that the symptoms are connected with the gastro-intestinal tract and not with the ear. Quite fre-

quently the otologist finds no pathologic changes of any kind, in other cases only slight pathologic changes. Another feature concerning these patients is that they cannot hold fluid no matter by what routes it is introduced. It disappears almost as rapidly as it enters the body. Another striking thing is the way in which the symptoms disappear after operation. The temperature drops, the dehydration becomes less, the gastro-intestinal symptoms subside and in a few days the baby is as well as prior to the onset of the infection. We saw one patient last winter in whom the symptoms were exactly the same and the child had acute sinus disease without mastoiditis. After drainage of the sinuses the condition cleared up equally as promptly as in the cases in which the mastoid was involved.

Another feature of this type of infection is its confinement to the period of infancy. We have seen no cases in children over 15 months of age. In one child, aged 2 years, after several weeks it was ultimately proved that mastoid infection was present. Over this period of several weeks the baby gradually lost in weight, but the whole illness was more chronic than one sees in the younger babies.

DR. GITTINGS: I would like to ask Dr. Marriott whether blood cultures were taken in any of his cases.

DR. LAFETRA: I want to ask whether, in the absence of any abnormal signs in the drum or mastoid, if Dr. Marriott would operate on the mastoid, which side, or both?

DR. ABT: The essayist calls attention to a condition which has been recognized for some time. Parenteral infections with the focus in the pharynx, middle ear and paranasal sinuses, are well known etiologic factors in the production of diarrheal diseases of infancy. But this is not all. There is a large group of nutritional disorders which depends on food disturbances and another group that depends on enteral infections. These facts have not been disproved, and I am sure that the essayist would not wish to be understood as saying that the diarrheal diseases occurring in the summer time are due for the most part to parenteral infections. It seems to me that it is timely to call attention to the rôle of mastoid infections as a cause of intestinal disturbances. But, on the other hand, it would be a mistake if we exaggerate the situation. A great many mastoids might be opened unnecessarily. It is not always a simple operation to open the mastoid. Very often the conditions which follow the operation become more serious than if a more conservative plan had been followed.

DR. MORSE: Dr. Marriott made some preliminary statements to which I must take exception. I do not agree with him that it has been proved that milk sugar is not suitable for the artificial feeding of babies. My belief is that it is the sugar of choice in artificial feeding. I agree with him that the place for the stools is in the slop pail, but not until they have been carefully examined. His method of putting them in the slop pail without examining them suggests to me the old "sink test" so often used by house officers for urines. Dr. Abt has already said many of the things that I wanted and intended to say. Dr. Marriott has undoubtedly proved his case in a certain number of instances. This does not indicate, however, that all cases in which there is dehydration, fever and prostration are due to mastoid infection. If the mastoids were opened in all cases in which these symptoms were present, I feel sure that we would be jumping from the frying pan into the fire. Again, why is it, if these symptoms are due to mastoid infection, that they are not present in many cases of known mastoid involvement? As a matter of fact they are unusual in mastoid infection secondary to acute otitis media.

DR. KERLEY: Dr. Marriott's discussion was very timely in calling our attention to ear involvement in athreptic infants. I am sure that many such cases as he describes are overlooked.

Several years ago, Baginsky of Berlin published the results of a series of necropsies on infants dying from various causes, in which infection of the

middle ear and mastoid were present in a considerable percentage of the cases. This ear involvement was not suspected during life.

DR. GRULEE: Every fall and winter we have a series of cases of respiratory tract infection, showing a certain symptom complex which differs from year to year. We had such a series of cases this year and one of the symptoms was the diarrheal condition of which Dr. Marriott has spoken. The question is whether this type of infection is simply peculiar to this year or whether it is something that can be regarded as acute intoxication. With reference to the question of opening the mastoid in these cases, it seems to me that we should be rather conservative.

DR. SHAW: I would like to ask Dr. Marriott whether he finds these symptoms the same in the winter as in the summer.

DR. R. M. SMITH: What means have we to differentiate mastoids that are in such condition that they should be opened? Have these children been examined with the roentgen ray?

DR. C. H. SMITH: Is the discharge any guide as to the involvement of the antrum?

DR. MARRIOTT: The symptoms in these cases probably are not due to septicemia. Blood cultures taken during life are usually negative. There is occasionally a terminal streptococcus septicemia.

There is, of course, the danger that too many mastoids will be opened. The general symptoms are the best guide for operation. The diagnosis of mastoid involvement is often made by exclusion. The operation is a simple one and does no particular harm if the mastoid is not infected. On the other hand, the lives of many of these infants can be saved by early operation.

The operation should be referred to as postauricular drainage rather than a mastoid operation, as it is much simpler than the operation in older persons. Occasionally an opening made in the wall of the canal at the point of the sagging brings about drainage, as the bony canal is not completely closed in infants. Such an incision, however, usually closes quickly and before adequate drainage has been accomplished.

Roentgen ray is of greater diagnostic value in older persons than in infants, as the mastoid is not pneumatized during early life. There is a single antral cell which rarely shows up in the plates.

Most of these cases occur in the late summer or fall. The infection is likely to be acquired by infants in poor nutritional condition, especially those who have been fed badly during the summer months. We have seen a large number of these cases during the last fall and winter, but I believe there have been just as many during other years which have not been recognized.

Dietary treatment is important. The infant should be given plenty of food to build up the body and should not be starved in order to treat the diarrhea. Any form of feeding is likely to fail unless the infection is dealt with.

THE RÔLE OF SODIUM CHLORID IN INFANT FEEDING. Preliminary Report. Presented by DR. ROOD TAYLOR.

The intake and output of chlorin is small in infants.

It has been learned from animal experiments and from studies on adults that the secretion of gastric hydrochloric acid is accompanied by a diminution of the blood chlorin. It has further been observed that when the chlorin reserve of the organism sinks under certain limits there is a diminution of the gastric hydrochloric acid. Keller found both diminished blood chlorin and gastric anacidity in infants with "mehlnährschaden." More recently, the gastric acidity has been found to be low in tetany in which the blood chlorids are reduced. Finally, Davidsohn reports increased gastric acidity in eczema, which is supposed by some to show also an increased chlorid retention.

Our findings suggest that in early infancy the sodium chlorid concentration of the blood is diminished, and that the addition of 0.5 per cent. of sodium chlorid to whole undiluted milk, in most cases, prevents dyspepsia and increases the hydrogen ion concentration of the gastric contents.

DR. TALBOT: This is an interesting subject because common salt is so widely known that the assumption is that it is a perfectly safe drug or food to use. If there is 0.5 per cent. salt in a liter of water you give 5 gm. sodium chlorid. I think it ought to be borne in mind that this is pretty close to the possibility of salt fever, the limit of which is 2.7 per kilogram; in a 10 pound baby that would be 7 gm. Salt fever, though it produces only a temporary effect, is not uncommon, and I simply speak to draw attention to it as a possibility. In some clinics it has not been recognized at all. The symptoms last only a few hours and then disappear. There is, however, the possibility to be considered; if salt is given in a concentrated fluid, and not scattered over a twenty-four hour period, the kidney function may stop so that there will be definite acidosis. It does not seem possible that anything of that sort would happen the way Dr. Taylor administers the salt over twenty-four hours, but if all the salt were given at once it might happen.

PECULIARITIES IN THE ANAPHYLACTOGENIC ACTION OF MILK PROTEIN. Presented by DR. E. C. FLEISCHNER, DR. E. B. SHAW (by invitation), and DR. PEARL BRISTOL (by invitation).

The effect of milk protein from an antigenic standpoint has been studied exhaustively by both feeding and injection experiments and its specific character has been definitely established. In reading the literature, however, one is impressed by the striking number of individual exceptions among the experimental animals, particularly in the feeding investigations.

A survey of the published data dealing with the anaphylactogenic action of milk protein justifies the following conclusions:

1. Milk is capable of developing an anaphylactic state in animals following parenteral injections.

2. There is, however, a marked variation in the manner and degree with which different animals react.

3. Milk is likewise capable of developing definite anaphylaxis in guinea-pigs that have been fed over varying periods of time.

4. The production of a reaction by this method of sensitization, however, is attended by many individual exceptions and is by no means constantly positive.

5. The heating of milk—at least to a temperature beyond which it is never used for human consumption—has no effect on the antigenic action of the casein.

6. The casein of cow's milk and the casein of goat's milk sensitize mutually to each other.

In an effort to confirm graphically these deductions, and to gather data as to the effect on the antigenic action of milk protein of the processes to which the various preserved milks are subjected in their preparation, a series of experiments were carried out, using the Dale technic on the uteri of virgin guinea-pigs.

CONCLUSIONS

1. The results confirm the observations previously made on the anaphylactogenic action of milk protein.

2. It is possible to sensitize animals both by feeding and injection experiments.

3. These short series would seem to indicate that following the subcutaneous injection of cow's milk, sensitization occurs more readily than by feeding.

4. The development of an anaphylactic state seems much more difficult of accomplishment after intraperitoneal than after subcutaneous injections of milk protein at least in doses of 1 c.c.

5. Notable exceptions occur, however, in all types of experiments, demonstrating beyond doubt that the reaction must be associated with definite peculiarities in the individual animals or groups of animals.

6. Animals sensitized to cow's milk react equally to goat's milk, and, vice versa, cow's milk is correspondingly toxic to animals sensitive to goat's milk, showing that, at least from an anaphylactogenic standpoint, the casein of the two products is identical.

7. No evidence has been deduced to show that the various methods of processing, to which the preserved milks are subjected in their preparation influences in any way the anaphylactogenic action of the milk protein following parenteral injection.

8. On the other hand, whereas the number of animals observed is too small to warrant dogmatic conclusions, the development of an anaphylactogenic state following the feeding of preserved milks seems more difficult than after the feeding of raw milk.

DR. SCHLOSS: Dr. Fleischner mentioned the observations of Wells, Osborne and myself, showing that the continued feeding of foreign protein to guinea-pigs leads to sufficient absorption to cause sensitization and later, antisensitization. Anderson, Dubois, Miss Myers and I have found that practically the same thing happens with infants. Feeding a foreign protein provokes the appearance of specific precipitins in the blood and the development of an intradermal reaction to the protein. After the protein has been fed for some time these reactions disappear.

It is interesting that Dr. Fleischner's observations show that the ingestion by guinea-pigs of milk denaturized by heat or drying does not lead to sensitization. It has been known for some time that the denaturization of proteins by any means reduces but does not abolish entirely anaphylactic action both in sensitizing and in intoxicating when given parenterally. This is probably due in large part to a reduction in solubility.

Work by Fleischner, Bauer, Wells, Anderson, Miss Myers and myself and others indicate that immunilogically casein probably is not species specific but chemically specific. In this respect it resembles the crystalline lens and sex organs.

DR. FLEISCHNER: The short time allowance prevented me from entering into many questions. We fed animals with a large number of preserved foods and were unable to demonstrate by the Dale technic that these foods produced sensitization. There are many interesting problems in connection with the subject. We had a 7 months' old baby develop a marked asthma when fed cow's milk. The child gave a cutaneous reaction to goat's milk also. The child could not take the cow's milk, but could take the goat's milk if it were given in very small quantities. We recognize that the protein in the whey is able to play a very definite rôle, and it may be that the coagulation of the whey proteins may exert some influence in diminishing the anaphylactic reaction to preserved milks.

VARIATIONS IN WEIGHT FOR HEIGHT IN CHILDREN OF SCHOOL AGE. Presented by DR. HAROLD K. FABER. Published in full in September issue.

DISCUSSION

DR. R. M. SMITH: This paper presents some important points for us to consider. It seems to me that it is desirable that we should find, if possible, some method by which to predict the proper gain in weight for a particular child. What we want to know is whether a given child is making the progress which he should make. We have had no contribution that is a guide in this respect. In all of our tables there have been so many persons above and below a so-called normal that our averages have not been accurate. In order to ascertain whether a particular child is gaining properly, we need a continuous

record of that child. At the present time there is no better way of judging a child's progress than by comparison with the group average.

DR. DEBUYS: I am in accord with what Dr. Smith says. In a large series such as the one studied by Dr. Faber, the law of averages comes into play and the results are certainly valuable. When speaking of standards, the terms most frequently used to denote those whose weights are a little more or less than the average for the age are overweight and underweight. Are these persons actually overweight and underweight or are they above weight and below weight? While above and over are somewhat similar as to their meanings as are also below and under, yet there is some distinction. Above weight signifies a proper proportion between weight and height when the individual's weight is more than the average; as also does below weight signify a proper proportion when the subject's weight is less than the average, whereas, overweight and underweight signify a disproportion between weight and height. It seems to me if we study separately a large series, including those above weight and below weight and exclude those who are overweight and underweight, that we would be better able to arrive at accurate standards, and we would better be able to judge what the average gain should be.

DR. LAFETRA: In view of the fact that Dr. Faber is trying to make an accurate study of heights and weights in relation to several factors such as nutrition and undernutrition, I would like to ask whether he has considered the factors of heredity and ethnology. Those points would be of interest, for in San Francisco he has many Chinese and Japanese. In New York we have Italians, Hebrews from Eastern Russia and Chinese and Japanese, and we have found that the heights and weights among this portion of our population are distinctly lower than those of men coming from the Highlands of Scotland, from New Hampshire and from the great open spaces of the West, where the men are very tall. As an illustration of this, you know the Dartmouth football team is noted for the size of its men, who have inherited their size.

DR. ROYSTER: On the racial side I have no statistical data to present, but I am working on some comparisons between the whites and negroes. We have studied about 4,000 or 5,000 of each race. The negro is certainly heavier than the white for the same height. In our tuberculosis clinic, where we serve both the colored and the white races, even the children of the colored race who had definite pulmonary infections with tuberculosis were carrying a better degree of nutrition than the white ones. When the white children usually come in with marked malnutrition, it was exceptional to find a colored child in the early stages of the disease that showed any marked degree of underweight.

DR. TALBOT: I think Dr. Faber has brought out one very valuable contribution in the fact that the underweight limits were not as close as 7 per cent. The wide variation is within the range of normality and in this discussion it should be remembered, and it undoubtedly is, that we are dealing with averages not as we want to find them—ideal physical development—but as we do find them. There is an error in nearly all the work we have to depend on, but that does not take from the value of it. In the majority of instances these children who are used are not controlled by physical examination or by clinical estimations of physical fitness. If someone could give us the same series with that check we would have indisputable duplicates with which to compare our figures.

One point of interest is that the variability of the female is greater than that of the male. This has been the reason of many inquiries that come to our laboratory, such as "How can we determine the basal metabolism of older girls?" It is this great variability in the girls that makes the determination of their metabolism so difficult and which must be taken into consideration in estimating their metabolism.

DR. C. H. SMITH: Dr. Faber said something about weight and height being only a step in the diagnosis of malnutrition. In this connection I should like to call attention to an ambiguous use of the term "nutrition" which has crept in

and which affects the whole problem of malnutrition. The solution of this problem has fallen into the hands of two groups, the dietitians and the physicians. Of these, the former are the more active because they are mostly on a full time basis and have no distracting other work. The New York Nutrition Council represents some ninety organizations and its meetings are attended by from 150 to 200 persons, among whom there are rarely as many as ten physicians. Naturally the dietetic aspect is the one which appeals most strongly to these trained dietitians. So-called "nutrition workers" are trained with chief emphasis on this side of the problem. The city and state appoint many nutrition workers, who largely teach that children must not eat meat until they are 8 years of age and that all children must eat spinach. These dietitians do not know medicine, they do not know much physiology, and they do not know all the practical application to the individual of the science of dietetics. When this group of "nutrition workers" speak of "nutrition" they are thinking of foods and food values.

The term "nutrition" is misused by the medical group in exactly the opposite direction, namely, to include not only the fat, muscle and bone of the child, but also all his physical defects. It seems to me that we should more carefully define the term nutrition. It ought to be confined to the "upholstery" of the body, the fat and muscle, while anatomic defects should be regarded as additional reasons for ill health. It is difficult to find the right word, but it seems to me that the word "physique" is a better term for what many include in "nutrition" at present. It suggests what we find as a result of physical examination or what is often called "general condition," and this term might be used to include nutrition, anemia, physical defects and even mental defects without much stretching of the word.

I feel strongly that this talking at cross purposes is a distinct handicap in the ultimate solution of this important problem. A clear definition of fundamental terms is a good foundation for any campaign.

DR. FABER: In reply to Dr. Richard Smith's remarks, we have made some studies of expected gain, but are not yet ready to state the results; the problem is a complex and difficult one, and here again individual variation is of great importance.

I should have made it clearer that my statistical conclusions were based, not on averages, but on modes. The mode is the point of greatest frequency and is uninfluenced, in contrast to the mean or average, by figures outside its range. The error suggested by Dr. DeBuys and Dr. Talbot, that the figures may be unduly influenced by the inclusion of unequally distributed data, or of excessive numbers of pathologically underweight or overweight children, is thus avoided. It was interesting to find that the modes of our groups corresponded closely to the Baldwin-Wood standards. In estimating the variabilities I omitted a small proportion of extreme varieties, but with much caution.

Answering Dr. LaFetra and Dr. Royster, I do not think that my figures were much influenced by racial differences. The proportion of Orientals to the whole was very small. The great majority of our children are native and many of them second generation Americans.

The chief purpose of this paper is twofold: to call attention to the existence of differences of variability, and to protest against the absolute interpretation of individual variations from the normal. About all we can say of a given child's weight for height is that it places him in a certain rank with his fellows, a datum which must be interpreted in the light of other physical findings. Such tables as I have presented make a rough ranking of this sort possible.

I thoroughly agree with Dr. C. H. Smith that we need a better definition of, or else a new term for what we have been calling "nutrition."

MALNUTRITION IN INFANTS WITH CLEFT PALATE, WITH A DESCRIPTION OF A NEW EXTERNAL OBTURATOR. Presented by DR. JOHN A. FOOTE. Published in the September issue.

CONCLUSIONS

Infants with cleft palate during the first year of life are frequently below normal nutritional standards. Such infants take less quantities of fluid food than normal infants. Diminished negative pressure in the mouth causes such infants to work at a mechanical disadvantage in taking nourishment. The use of a simple external obturator restores the condition of negative pressure in the mouth and causes a gain of weight in suitable cases.

DISCUSSION

DR. NEFF: That the effort expended in nursing the breast is greater than that in taking the bottle, presupposes that the rubber nipple has a sufficiently large hole. We have all seen instances of the perspiring and exhausted infant trying ineffectually to empty a bottle that has become completely stopped.

DR. MCCLANAHAN: I have seen many of these cases. I have had sixty-eight cases in the last four years. We have a very skilful surgeon who cooperates with us. We use a Breck feeder and the babies get along nicely. This point I wish to make: The surgeon never operates on a patient until the pediatrician gives orders to do so. We get the child into the best condition before we give that permission and this policy has certainly lowered the mortality. We have taught the surgeons some lessons and have accomplished something in that way.

Two infants did badly during the operation and the operation was stopped. We found the difficulty was due to thymic enlargement and after two roentgen-ray exposures, operation was carried out successfully. These children pass through operation satisfactorily when properly treated medically, and when the operation is performed at the correct time. We may expect better results if the surgeon is advised when to operate.

SPONTANEOUS RECOVERY OF MASTOIDITIS WITHOUT OPERATION. Presented by DR. R. G. FREEMAN.

The general attitude of the physician with reference to a case of distinct mastoiditis, with excessive purulent ear discharge and tenderness over the mastoid, and roentgen-ray evidence of mastoid involvement, is immediate operation and drainage. This relieves the physician in charge of the mental anguish he would suffer if the patient did badly without operation, and it is unquestionably the best method of treatment in most cases. But while the mastoid operation provides the necessary drainage and usually leads to an uneventful recovery, it is followed by a long period of very painful dressings, and is an operation that requires skilled and experienced hands. It has, therefore, seemed to me worth while to report the following case of spontaneous recovery without operation.

W. H., a boy, colored, aged 7 years, was admitted to Bliss ward of the Roosevelt Hospital, with a history of five days' pain in the left lower side of the chest and precordium, accompanied by fever and cough. The right ear drum was inflamed and dull, and there was dulness on percussion over the left side of the chest with diminished breathing. At the apex there were bronchial breathing and crepitant râles.

The right ear drum was opened immediately and the one on the left side had to be opened a few days later. The boy developed pneumonia of the left upper lobe, as shown by physical examination and roentgen ray. He later developed an exudate in the left side of the chest, at the same time showing tenderness over the right mastoid. A roentgen-ray plate at this time, nine days after admission, showed evidence of infection of the mastoid.

The otologist, Dr. Howell, was called in consultation concerning the mastoid, and did not advise immediate operation. The temperature at this time was 101 F.

The following day the temperature was normal, the discharge from the ear was less, and the mastoid tenderness was materially diminished. The temperature, however, rose with an exacerbation of the chest condition, and it was two weeks later that the temperature finally reached normal. During all this time there were no more mastoid symptoms, but the roentgen-ray pictures showed mastoid involvement which was still present to some degree when the child was discharged from the hospital, two and one-half months after admission.

It seems from this experience that it is possible with the mastoid, as well as with a bulging middle ear, that operation may sometimes be deferred with advantage, if the constitutional reaction is not severe. In this case the symptoms indicating operation—the fever, tenderness and excessive ear discharge—all disappeared soon after the condition was diagnosed.

The results in this case should not encourage any one to defer operation for mastoid if persistent symptoms indicate its necessity.

DISCUSSION

DR. CARR: Two extremes are represented by Dr. Freeman's and Dr. Marriott's papers. It is not unusual to see patients with middle ear disease and mastoiditis with vomiting and diarrhea. Disturbances of digestion and intestinal trouble are quite common when there are middle ear and sinus infections. Dr. Marriott has referred to the anatomic structure of the ear in infants, but we may find variations in early infancy in the mastoid cells. In connection with the type of infection we may have a general infection with an ear involvement which is due to a streptococcus or we may have a general infection with mastoiditis associated with pneumonia, empyema and endocarditis. A recent epidemic caused by streptococcus infection has given mastoiditis and pyelonephritis together, the latter being rather uncommon compared with the infections of the lung. Blood cultures in these children have almost always been negative even when the cultures from the ear have been definitely positive for streptococcus or pneumococcus. As many of these children are slow in regaining their blood making and nutrition, they will need diet regulation and some of them will require transfusion before they begin to gain. As mastoiditis is not always caused by the same organism we may have an apparent cure in a mild type of infection which later will require operation. In properly conducted hospitals operations performed are seldom unnecessary, and in 225 mastoid operations done in the New York Eye and Ear Infirmary two, less than 1 per cent., were thought to be on patients who could have had operation delayed. The roentgen-ray plates have shown great differences in the condition of the mastoid cells and have been most helpful in determining the extent of invasion.

DR. SHERMAN: I think the tendency of the aural surgeon to operate early in the mastoid infection is fortunately decreasing. They are wisely considering the type of infection, whether low grade or virulent, and prefer to delay a few days, if possible, that a protecting lymph wall may form around the focal point.

We in Buffalo are relying less and less on the roentgen-ray findings as the important final indication for operation. We consider the clinical aspects of the case, both local and constitutional, are safer evidence for operative procedure. Given a bulging drum with accompanying mastoid tenderness, we open the ear. If the discharge is free or profuse we stand pat, but as soon as it becomes thicker and lessens, almost stops, with the mastoid sensitiveness persisting, especially with some evidence of septicemia, we operate at once.

DR. KERLEY: I recall a case several years ago before the roentgen ray came into use, in which the patient, a boy, aged 2 years, had a very definite mastoiditis in whom there was also an acute endocarditis. On account of the condition of the heart, mastoid operation was not to be thought of. After several weeks of drainage the child recovered, but with a perforated membrane in both ears. There is no question that many cases of mastoiditis recover without operation;

the drainage through the ear ceases after a time. The end-results, however, particularly as regards the hearing, would have been better had a mastoid operation been performed.

DR. HEIMAN: I am glad to have the opportunity to register a word of caution as to promiscuous mastoid operations. This does not refer to the work of reputable otologists or hospitals, but we all have observed cases like Dr. Freeman's in which we were dealing with a periostitis instead of a real mastoid involvement. There is no reason why a child with mastoid trouble should not recover without operation in some cases, but when I suspect mastoid involvement I always invoke the aid of a good otologist before subjecting the child to operation. We all believe that some mastoid infections are blood infections, and if there is a high temperature we should be exceedingly careful to advise operation on such a child.

DR. FREEMAN: I hope I have made it clear that I am not recommending this treatment. In this child, twenty-four hours after making the diagnosis, the symptoms subsided, the fever fell, the ear discharge diminished with no bulging of the drum, but two months later there still was roentgen-ray evidence of infiltration of the cells.

THE DIURETIC EFFECT OF SODIUM BICARBONATE IN NEPHRITIS WITH EDEMA. Presented by DR. KENNETH D. BLACKFAN and BENGT K. HAMILTON (by invitation).

Within recent years the relationship between the chief presenting symptoms in nephritis and acidosis has been the subject of much discussion. Although as some writers believe, acidosis plays little or no part in the production of the symptoms, other writers have expressed the opinion that the symptoms met with are entirely dependent on an increase of acidity in the body fluids. It was only logical that those who favored the latter point of view should have advocated the use of alkalis in the treatment of nephritis, not alone to hasten diuresis but to counteract the acid effect which existed as well.

Various objections have been raised against the use of alkaline salts in the treatment of edema of renal or other origin. According to certain theories relating to the exchange of fluid between the blood and tissues, the presence of alkalosis in the blood would tend to increase the retention of tissue fluid. Many reports in the literature are cited in which these salts, when given, have caused an increase in the edema. On the other hand, there are many reports which show that beneficial effects, by increasing the urinary outflow and thus relieving edema, may follow the use of alkaline salts.

Last year we reported to this Society observations made on the treatment of edema with salts which produced an acidosis. We found that such salts as calcium chlorid, ammonium chlorid, magnesium sulphate and ammonium sulphate, produced a marked acidosis when given in proper amounts, and that a diuresis with loss of edematous fluid paralleled the acidosis. We wish today to present the results of studies showing the effect of sodium bicarbonate in patients with acute tubular nephritis and edema, who have not responded to treatment with acid producing salts.

We have found that when sodium bicarbonate in suitable amounts is given to a patient with this form of nephritis, that an immediate and marked diuresis may follow. When the bicarbonate is discontinued the diuresis ceases. When the amount is increased so that, as we are inclined to believe, an alkalosis results, there likewise is a diminution in the urinary output and an increase in the edema. It was also found that excessive amounts of sodium bicarbonate may be given to certain patients, followed by a diuresis, without causing an alkalosis. We have not been able to find any constant relationship between the hydrogen ion concentration of the urine and alkalosis as indicated by the plasma bicarbonate following the use of this salt. The results are illustrated in the following case reports.

CASE 1.—A boy, aged 6 years, was suffering with acute tubular nephritis and edema. Calcium chlorid was given without any diuretic effect. He was first given 2 gm. of sodium bicarbonate daily. There was a temporary effect, but soon the urinary output returned to its former low level. Following the administration at different periods of 3 gm. and then 4 gm. daily, an immediate and marked effect was obtained. When sodium bicarbonate was discontinued, the diuretic effect ceased. The *p*H of the urine during the period of administration, remained quite constant, around 7.0 to 7.6. The plasma bicarbonate was 48 per cent. by volume before treatment and 57 per cent. by volume during treatment.

CASE 2.—A boy, aged 4 years, was suffering with acute tubular nephritis and edema. A marked diuretic effect followed the administration of first 3 gm. and then 4 gm. of sodium bicarbonate. When, however, the dose was increased to 5 and 6 gm., the reverse of a diuretic effect was observed. There was a diminution in the urinary output and an increase in the edema. Subsequently it was shown that when 5 gm. of sodium bicarbonate was given to this patient there was a marked alkalosis—the plasma bicarbonate rose to 82 per cent. by volume.

CASE 3.—In this diagram is shown the effect of extremely large amounts of sodium bicarbonate given to a boy with acute glomerular nephritis without edema. As much as 18 gm. was given to this patient; although there was a moderate diuresis, alkalosis did not result. The plasma bicarbonate was 50 per cent. by volume before treatment, and 70 per cent. by volume during treatment.

Thus it seems from these observations that in order to cause an alkalosis there need be assumed a certain degree of renal injury and that if an alkalosis results, the diuretic action is held in abeyance.

Further studies are necessary before an explanation can be offered regarding the action of sodium bicarbonate in liberating edematous fluid from the body tissues. Certain observations which we have made may have an important bearing on this point. We have found that the total fixed base in acute tubular nephritis is invariably lower than normal (from 140 to 150 c.c. tenth normal compared to 155 to 160 c.c. tenth normal per hundred cubic centimeters of serum). This low value is raised by the administration of sodium bicarbonate. As there is also a slight increase in the plasma bicarbonate, but without a decrease in the chlorids to offset the increase of this value, that is, plasma bicarbonate, it is probable that the total ionic concentration of the blood must also be increased. An increase in the total ionic concentration of the blood and the resulting increase in osmotic pressure might possibly explain the diuretic action of this alkaline salt.

A STUDY OF THE ACID-BASE EXCRETION OF AN EPILEPTIC. Presented by DR. JAMES L. GAMBLE and DR. BENGT HAMILTON (by invitation).

The data presented show in detail the acid-base composition of consecutive twenty-four hour urine specimens from an epileptic child over a period of twenty-seven days, which included four two day periods of severe seizures separated by intervals of four to six days. The diet given was accurately constant as regards its acid-base composition and a stationary level of fluid intake was also maintained. A large increase in the total acid excretion was found to occur during the periods of seizures. This was closely paralleled by an increase of total fixed base. The increased total acid was chiefly composed of chlorid ion. The base loss was almost entirely sodium. The reaction of the urine and its ammonia content was not appreciably altered. Measurements of the concentrations of fixed base, chlorid and bicarbonate ions in blood plasma samples obtained just preceding and during the period of seizures, and in the intervals between, showed no significant alteration of the normal composition of the plasma. Measurements of *p*H in the plasma were also closely stationary and normal. It is inferred that the increased total acid and fixed base excretion must have been

accompanied by excretion of a portion of body water. This explanation is supported by roughly corresponding changes in urine volume.

In an effort to determine whether or not the loss of body fluid should be regarded simply as a result of seizures, a second period of study was carried out, during which seizures were prevented by administration of phenobarbital (luminal). The measurements obtained were not decisive. A considerable irregularity of chlorid excretion was found. The extensions, however, were much smaller than occurred during the periods of attacks. The authors, therefore, feel that the results of their study cannot be regarded as definitely of pathogenic significance.

DISCUSSION

DR. MARRIOTT: The question arises whether the changes in the water and salt metabolism are the cause or the result of the convulsions. It would be of special interest to see if similar phenomena take place in animals rendered convulsive by strychnin. During convulsions there is increased muscular activity and consequent increased production of carbon dioxid. At the same time there is usually decreased pulmonary ventilation as the result of apnea. This necessarily leads to an increase of carbon dioxid in the blood and it is known that such an increase of carbonic acid leads to a migration of alkali salts from the cells into the plasma. This increase in the salt content of the plasma would naturally lead to diuresis with excretion of salts and water. This may be a possible explanation of the findings.

DR. HOWLAND: At the same time that there was a loss of salt and water, was there an increased excretion of nitrogen?

DR. KRAMER: There is some evidence that stored glycogen is used up and the water bound to it, therefore, liberated for excretion. I do not know in what form the water is fixed in the body. If it is fixed as the ordinary tissue water it would have the same composition as tissue water, and with the loss of this water we would have a loss of anions and cations in the urine such as was observed by Dr. Gamble.

DR. TALBOT: An interesting question in connection with all this work is the question of the definite therapeutic effect of acidosis on these patients. In some recent work, Peterman shows the results of treating these patients with a diet that causes ketosis. This treatment seems to offer hope that it may possibly help them.

DR. GAMBLE: I am quite willing to admit that the most probable explanation of these findings is that they are produced by the seizures in some such way as Dr. Marriott and Dr. Kramer have suggested. In answer to Dr. Howland's question; there was a quite measurable increase in urinary nitrogen during the seizures.

CONGENITAL TRANSDUODENAL BANDS. Presented by DR. FRANK C. NEFF and DR. RUSSELL L. HADEN (by invitation). Published in the July issue.

DISCUSSION

DR. JULIUS H. HESS: We have recently had a case almost the exact counterpart of the case cited by Dr. Neff. Children with congenital hypertrophic pyloric stenosis usually go for a considerable period of time before vomiting starts, as there may be very little obstruction in the region of the pylorus at first. When there are bands and adhesions, vomiting is more likely to start early. In our case the roentgen-ray report showed that a very considerable amount of barium passed through the pylorus. Following improvement without operation, the child left the hospital at the end of three weeks, but was seen by us occasionally for about five months, when he seemed to be making fair progress. When the child was about 9 months old, we received word from the mother that he had vomited a large amount of blood. When brought to the hospital

the child was almost moribund. A blood transfusion was given, using 8 ounces of the father's blood. The child made a fair temporary recovery and after a second transfusion the progress was such that we allowed him to go home with instructions for return in about ten days for operation. We thought the child had some pyloric obstruction with resulting varicose veins at the pylorus which might have ruptured. The child returned in about three weeks and was given a barium meal. The surgeon stated that the roentgenogram showed absence of the cap of the ampulla and that the condition, if one of hypertrophic stenosis, was an atypical one. On opening the abdomen a very much dilated duodenum came into view. The upper part of the duodenum was about the size of the stomach and about 3 inches in diameter at the seat of the pyloric ring. The question was, what to do. An attempt was made to lift the duodenum from behind the liver, but as difficulty was encountered a gastro-enterostomy was performed. Next a strip of fascia was taken from the anterior sheath of the rectus and used to make a pyloric closure, by suturing it around the dilated pyloric ring. The infant made a rapid recovery, and returned in two weeks for further examination. A bismuth meal disclosed a patent gastro-enterostomy and complete closure of the pyloric ring.

DR. KERLEY: I have seen three cases in the new-born in which duodenal bands were present. One of the features of these cases diagnostically, in contradistinction to the cases of true hypertrophic stenosis, is that the vomited material contains bile and, of course, there is no palpable tumor. The persistent vomiting of bile the first few days of life does not necessarily mean that the duodenum is involved. The obstruction may be located anywhere in the intestine. A few years ago, I saw a case of this sort in which the transverse colon was festooned upward at a sharp angle by a fibrous band which completely encircled the intestine. We thought that there might be an intussusception and an exploratory operation was performed which revealed the seat of the trouble. In another case in a child, aged 9 months, there was persistent vomiting of bile stained mucus with extreme abdominal distention. We thought of intussusception, but no tumor could be made out by rectal examination or otherwise and there was no blood passed or evidence of blood on the examining finger. An exploratory operation was advised which revealed a slight tuberculous peritonitis with isolated tubercles scattered here and there, with a fairly massive deposit in the region of the sigmoid which effectually blocked the intestines. The intestines were released and the child made a satisfactory recovery.

In cases of evident intestinal obstruction an early exploratory operation is the only course to pursue.

DR. GAMBLE: I am entirely in agreement with Dr. Neff as regards the benefit of subcutaneous injections of sodium chlorid solutions in the presence of upper intestinal obstruction. I do not, however, agree with the theory which Haden and Orr have advanced, and which Dr. Neff cites, in explanation of the action of the administered sodium chlorid. Ross and I have found in dogs a loss of sodium as well as of chlorid ion in stomach secretions following experimental obstruction of the pylorus. Sodium chlorid solution thus replaces both of the lost electrolytes and completely repairs dehydration. I do not believe that the evidence advanced by Haden and Orr is adequate for the additional assumption of a specifically protective action of sodium chlorid against an hypothetical toxic body.

DR. SHERMAN: In the Children's Hospital three or four years ago, we had two new-born infants, one coming from Niagara Falls from a family whose other children had been under my care. The infant was brought to the hospital when it was 40 hours old, with symptoms of persistent vomiting. My diagnosis was congenital hypertrophic pyloric stenosis. There seemed to be no question about the condition. The child did not vomit any bile. An immediate operation was performed, and a mass was found at the duodenum with innumerable bands making compression and causing complete duodenal obstruction. These bands

were more or less easily broken up, and air entered and passed along the duodenum. Dr. Thew Wright operated and the child made a good recovery and has grown and progressed nicely. There has been no recurrence of the bands up to the present time.

Two days after this child came to the hospital, another child was admitted with the same symptoms and signs. In this case I was not so enthusiastic in making a diagnosis of congenital hypertrophic pyloric stenosis. Operation revealed not only adhesions, but a tortuous duodenum and a much greater involvement than in the first case. We hoped we would get the same good results as in the first case, but this baby was 5 days old, dehydrated and in a condition of severe shock. It died shortly after the operation.

DR. MCCLANAHAN: I am convinced that we have more cases of congenital anomalies in the new-born than we have recognized. At the Methodist Hospital Home we have permission to make necropsies and in one case a double ureter was found. Another case of anomaly I reported some years ago in which an early operation was performed. This suggests the thought that we do not feel unkindly toward the surgeon, but that we should be the judges as to when, where and how the operation should be performed. I have seen so many cases of congenital pyloric stenosis and after operation the majority of these patients recover and remain well. I have now about thirty-six patients who, following stenosis, are perfectly well. Exploration of the abdominal cavity is not a serious thing if properly done. We older men may have erred in postponing operation too long, but when men with Dr. Kerley's experience acknowledge that they occasionally find difficulty in making a diagnosis, we other men do not need to be embarrassed if we cannot make a diagnosis. In the last case of obstruction to a peritoneal band I had exploratory laparotomy performed and this certainly saved the life of the infant.

DR. TALBOT: The mechanics of obstruction is such that one clinical feature bears mention. That is illustrated by a baby, aged 8 months, who was in the clinic several years ago. We found that this child could retain its food and apparently empty its stomach when it took the knee-chest position. We assumed that there was a movable band that closed off the duodenum when the child was supine on its back.

DR. NEFF: I am sorry nonmembers of the Society cannot take part in the discussion, as Dr. Haden is here.

The three cases which we have seen stand out clearly as a clinical entity. Persistent vomiting may be due to an obstruction of this type, and one should not overlook the diagnostic value of determining the blood chemistry, particularly the chlorid depletion. By administering sodium chlorid subcutaneously or intravenously, this deficiency may be overcome and the child is in much better condition for operation.

FOURTH SESSION

THE USE OF HEXYLRESORCINOL, MERCUROCHROME-220 SOLUBLE, AND HEXAMETHYLENAMIN IN URINARY INFECTIONS. Presented by DR. H. F. HELMHOLZ.

A comparative study was made of the value of hexylresorcinol, mercurochrome-220 soluble, and hexamethylenamin as urinary antiseptics in experimental pyelitis in rabbits. Hexylresorcinol, in dosage arranged to produce bactericidal urine, was given to five animals with staphylococcus infections. The infection was cleared up in only one case. In another series, ten animals were given sufficient hexylresorcinol to make the urine bactericidal, and all of them developed abscesses in the kidney after intravenous injection of *Staphylococcus albus*.

Four series of experiments were done in which a group of four rabbits were treated with hexylresorcinol, four with mercurochrome-220 soluble, four with hexamethylenamin and four were used as controls. In the first series *Bacillus*

coli was injected intravenously and as soon as the infection was well established the drugs were administered. The control rabbits and those receiving hexamethylenamin were all living at the end of the experiment. Only the controls and the rabbits receiving hexamethylenamin showed a sterile urine. In the second series, *Bacillus coli* was injected intracystically and the same drugs administered as in Series 1. The results were not so uniform as in the previous series. The rabbits receiving hexamethylenamin cleared up more slowly. At no time did the infection in the rabbits receiving hexylresorcinol show any tendency to clear up. In the third series of experiments the animals were injected intravenously with staphylococcus. In this series all the animals, with one exception, receiving hexylresorcinol and mercurochrome-220 soluble, died before the experiment was completed. The striking feature was the rapidity with which the infection cleared up in the rabbits receiving hexamethylenamin. In the fourth series, the animals received *Staphylococcus albus* intracystically. In these experiments the colon bacillus very frequently replaced the staphylococcus in the urine. The experiments were interrupted because of the disappearance of the staphylococcus. In the intravenous series the staphylococcus was present constantly in the urine, and in no instance displaced by the colon bacillus.

Hexylresorcinol was used in only ten cases of pyelitis in children and in only seven cases in adults. Several patients whose infection failed to respond to hexylresorcinol were given hexamethylenamin, which cleared up the condition. Whether they would have been so benefited without the preceding hexylresorcinol treatment is difficult to say. The adult cases apparently received more benefit.

In experimental infections of the urinary tract with *Staphylococcus albus* and an organism of the colon group, with specific localizing power in the kidney, hexamethylenamin was more effective in clearing up the infection than either mercurochrome-220 soluble or hexylresorcinol. Hexylrosorcinol has not proved so efficacious as hexamethylenamin in treating chronic pyelitis in children.

DISCUSSION

DR. WILBURT C. DAVISON: I should like to ask Dr. Helmholz whether he can explain the disappearance of the pus cells before that of the infecting organisms. This is contrary to the usual observation in meningitis and other purulent infections in which the organisms disappear first. Dr. Veeder Leonard believes that if hexylresorcinol is continued long enough it will cure most of the infections. In Dr. Helmholz's cases the use of this drug was not very prolonged. A second point which should be mentioned is that in the cases illustrated in the first three charts, in which the use of hexylresorcinol was followed by that of hexamethylenamin, the infections apparently cleared up more rapidly than in the cases in which hexamethylenamin was used primarily.

DR. HEIMAN: Have you examined the urine in these rabbits before starting your experiments? We have found that we have been unable to obtain dogs with normal urine. We find that the dogs have posthitis, balanitis, urethritis, etc. It would be interesting to know whether you had normal urine in these rabbits before the experiments were made.

DR. ABT: Please tell us whether you have had any further experience with cystoscopy and pelvic lavage, and whether you have had any results with vaccine treatment and foreign protein therapy.

DR. HELMHOLZ: Since I shortened my paper, I failed to bring out the point raised by Dr. Davison. It is difficult to say whether after using hexylresorcinol we had any better results with our hexamethylenamin therapy. It is difficult in an individual case to determine exactly what procedure was of the most therapeutic value, and for this reason I was glad to obtain this colon bacillus so that I could adequately control my therapeutic experiments.

With regard to hexamethylenamin, there were such striking results in chronic cases that had persisted for a year or more that its value is evident.

All the control animals were catheterized and the urine cultured and examined microscopically before the experiments were started. In this way we found a considerable number of pyogenic infections of the urinary tract of rabbits.

In regard to Dr. Abt's question, we have not used vaccines; in all our chronic cases we have made cystoscopic examinations and have used local instillations whenever it seemed advisable to do so. I believe we have two different groups of pyelitis. In the one there is no anatomic obstruction to the flow of urine and in the other there is some obstruction. As Dr. Smith brought out so well at the last meeting, cases of the latter type are the ones that are difficult to clear up.

LARGE BILATERAL KIDNEY STONES IN A CHILD OF FOUR YEARS. Presented by DR. LINNEAUS EDFORD LAFÉTRA.

The roentgen-ray plate of a child who came under my care in the wards in January, 1925, is presented. For six months prior to admission the child had had intermittent pain in the hypochondrium, mostly on the right side, and during the three weeks preceding entrance to the hospital there had been three occasions when temporarily, with some access of pain, he had been unable to pass urine. Each time this difficulty in urination had been followed by the passage through the urethra of a small, rough stone. Since the passage of the third stone one week before coming to the hospital, the child had been without pain and with no urinary obstruction. There had never been any blood in the urine and jumping caused no pain.

Except for a somewhat congested throat and moderately enlarged cervical lymph nodes, the physical examination was negative on admission. The boy was well nourished, though a little pale; deep abdominal palpation did not elicit tenderness, tumor nor crepitation in the kidney region.

The child was put on an acid free diet and was given daily 1 dram each of potassium citrate and bicarbonate of soda. The urine became and remained alkaline at almost every one of the frequent urinalyses from the date of admission until his discharge, February 1. At no time were there any red blood cells in the urine and the white cells were never more than 10 per high power field; no uric acid crystals were noted, only triple phosphates and ammonium urates. The chemical bood tests on January 12 showed uric acid 4.2 mg. per hundred cubic centimers, 13.4 urea nitrogen, cholesterol 0.148 per cent. and chlorids 0.50 per cent. On the same date the red cells in the blood were 5,408,000. The hemoglobin was 11.5 gm. by weight per hundred cubic centimeters of blood, equivalent to 70.6 per cent. by Sahli's method. White cells 8,600, of which 77 per cent. were polymorphonuclears. The blood Wassermann test was negative and his temperature was normal. The water test, done on January 21, showed satisfactory secretion and no fixation of the specific gravity. The phenolsulphonephthalein test, 4.5 mg. being injected, showed 13.2 per cent. excreted in 200 c.c. of urine during the first hour and 7.1 per cent. excreted in 220 c.c. of urine during the second hour, a total of only 20.3 per cent. of the dye.

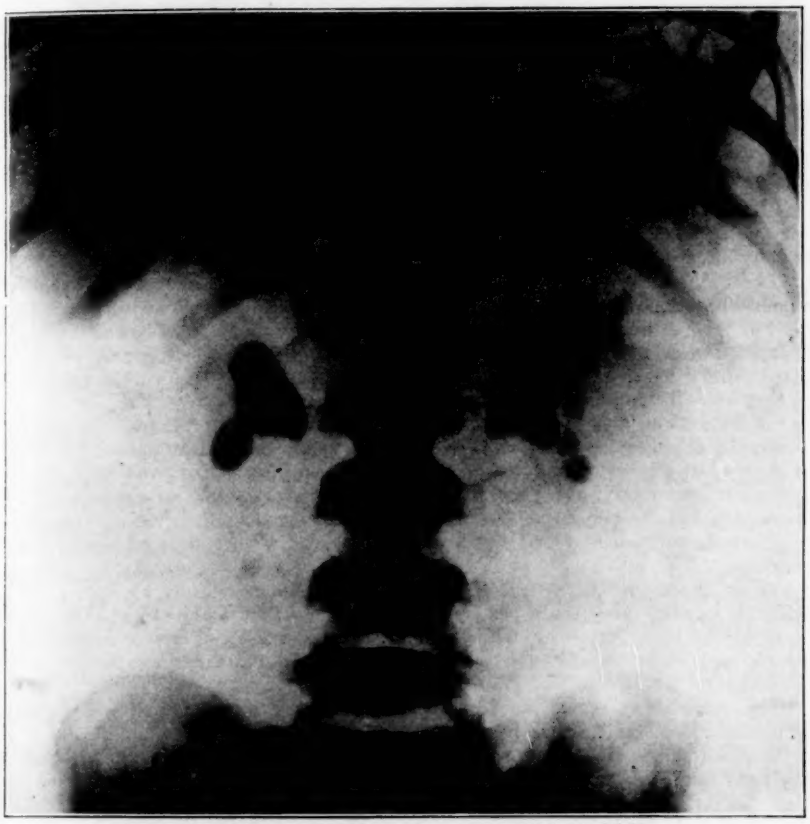
The roentgenogram taken on January 27, was interpreted by Dr. William H. Meyer, radiologist of the hospital, revealing "extensive double renal lithiasis. Large branching calculi in the pelves of both kidneys; deposits most numerous on left side, in which further faceted calculi are seen, mainly toward the lower calyx." Incidentally these shadows in the plate are the largest I have ever seen in any plate made on a child.

Naturally the question of nephrotomy arose and both on *a priori* grounds and because of the interesting and favorable report by Dr. R. M. Smith of this Society of a case (Case 4 of his series) in the *American Journal of Diseases of Children* for December, 1924, I was inclined to urge operation.

However, in my patient, operation was not done for two reasons. The family was opposed to operation, because the maternal grandfather, who lives in Galicia, a lithiasis district, was known to have had stone in the kidney for years; he is hale and hearty as always, and is now 65 years old. In the second place the attending urologist, Dr. Joseph F. McCarthy, gave his opinion that operation

was not advisable at the present time. He wrote: "The prognosis of this case, under any course, is extremely bad. It is debatable whether operation will lengthen or shorten his life. It is possible that operation by a pelvic nephrotomy on the presumably good side, followed later by a nephrectomy on the bad side, might effect a cure. On the other hand, it will probably shorten his span of life. In later life it is current practice in bilateral nephrolithiasis to operate only for the relief of symptoms. The parents' desire, after receiving a full explanation of the case, should be given serious consideration."

The boy left the hospital in excelient condition and was seen by me on May 1, 1925.



Large branching calculi in the pelves of both kidneys.

DISCUSSION

DR. R. M. SMITH: In reference to the case which I reported last year and of which Dr. LaFétra has spoken, Dr. Mixter removed the stones from the other kidney and at last report the child was doing well.

BIRTH INJURIES INVOLVING BOTH THE BRACHIAL PLEXUS AND THE CENTRAL NERVOUS SYSTEM. Presented by DR. BRONSON CROTHERS and DR. MARIAN C. PUTNAM (by invitation).

In 1923, one of us suggested that injury of the spinal cord, due to obstetric accidents, was an important cause of paralysis in childhood. This hypothesis was supported by a considerable amount of pathologic evidence, by scattered cases

from the literature and by five cases seen at the Children's Hospital and in private practice.

Since the publication of that paper evidence has accumulated which justifies further discussion. This evidence is both pathologic and clinical. The outstanding contribution is the report of Pierson on the necropsy material at Sloane Hospital in New York. Further evidence has been given us through the courtesy of the obstetric and pathologic departments of the New Haven Hospital, who have placed at our disposal clinical and pathologic data, and a series of new cases has been studied by us.

The pathologic evidence on birth injuries which is available in the literature is conclusive on two points. First, cerebral injury is extremely common after all types of delivery, and second, the spinal cord is frequently damaged in extractions. These points have been abundantly proved and will not be discussed here.

Injuries of the brachial plexus are adequately proved by clinical and surgical investigations and the uncomplicated cases have been sufficiently studied by many writers, particularly by J. W. Severe and R. S. Taylor.

In going over the large number of cases of birth injury which we have seen during the last few years at the Children's and the Infants' Hospitals, we have been struck by the frequency with which injuries of the plexus have been associated with injuries of the brain or cord. Theoretically, this association is entirely reasonable since injury of the plexus furnishes proof that unphysiologic forces have been used in delivery.

The mechanism of normal labor involves expulsion of the fetus by pressure alone. Traction is an absolutely unphysiologic procedure. When the fetus is delivered by traction it is subjected to extension. Of course, breech deliveries furnish the most striking example since the whole spinal column may be elongated. But even in relatively simple head deliveries, the delivery of the shoulders is frequently hastened by lateral traction on the neck.

The spinal cord is firmly anchored above by the roots of the brachial plexus. When the arm is pulled, the roots on that side become tight and anchor the cord to the side of the vertebral canal. Intolerable strain does one of two things. First, and most commonly, the roots give way outside the cord, producing typical brachial palsies of the usual type or the roots are actually avulsed from the cord, producing paralysis of the arm and various disturbances of spinal cord function.

When cases with peripheral palsies of the arm are carefully studied, a considerable number, roughly 30 per cent., are found to show definite signs of involvement of the brain or cord. These added lesions vary from severe intracranial injuries and total transections of the cord to transient disturbances which clear up within a few months.

The conclusions which we feel are justified by evidence which will shortly be published in detail are as follows:

Brachial palsy is always evidence that the unphysiologic force of traction has been imposed on the baby, and it should imply that some abnormality or disproportion justified the use of this dangerous procedure. Therefore, it is logical to look for other lesions.

The clinical evidence can best be obtained by the type of study used by physiologists after experimental mutilation of the nervous system.

Four cases illustrate the clinical syndrome under discussion:

CASE 1.—An infant with involvement of both arms, the chest and the legs of severe type. Breech delivery.

CASE 2.—A child with a brachial palsy, paralysis of the chest and abdomen and spasticity of the legs. Difficult head delivery by midwife.

CASE 3.—A brachial palsy with slight and probably transient spasticity of the legs combined with asymmetry of the chest. Transverse followed by version.

CASE 4.—A slight brachial palsy combined with cerebral palsy involving the four limbs. Breech delivery.

DISCUSSION

DR. CARR: Dr. Sharpe of New York has published investigations on spinal cord punctures, and he shows a varying percentage in the results obtained which evidently give evidence of a difference in obstetric technic. A comparison of these punctures in greater numbers would be advisable before determining the association of blood in the spinal fluid with subsequent symptoms of birth injury. Twenty-six necropsy records of the new-born at the Woman's Hospital showed ten cases recorded as cerebral injuries with hemorrhage, but there were no notes as to whether these were in any way associated with hemorrhage into the cord or brachial plexus. Recently, at a clinical conference of pediatricians and pathologists of lying-in hospitals, the subject of birth injuries was taken up and the opinion seemed to be that there was no method of control so far as the pediatricians were concerned, but an effort is to be made as to whether some of the cases thought to be mechanical might not perhaps be due to blood dyscrasias and therefore amenable to treatment. Even if there is a mechanical injury, the injections of blood into the child seemed to have been helpful, but all such children deserve a long period of observation. The general opinion of the conference was that most birth injuries were due to mechanical causes and that blood dyscrasias were infrequent.

DR. ABT: In the diagram which you present showing crossed paralysis, would you not consider a hemorrhage into the pons? In breech deliveries there may be severe trauma to the aftercoming head, indeed, tentorial tears may occur. Do you not consider it possible that when there is extensive intracranial hemorrhage, blood may flow down through the subdural space of the cord and affect pressure and destruction of nerve cells and filaments of the cord? I should also like to ask how you determine sensory disturbances in these small babies.

DR. C. H. SMITH: What have you found in the relation of this type of combined birth injury to prematurity and easy labors? One frequently sees intracranial injuries in children small at birth and with a history of rapid labor.

DR. LA FÉTRA: An important factor in producing cerebral hemorrhage is the umbilical cord around the neck, especially if it is short or more than one turn. I made a study of the Sloane Hospital records some years ago, and found many cases in which there was neither great pressure nor traction and yet the tight cord superinduced intracranial hemorrhage.

DR. SHERMAN: I may have misunderstood what was said about sweating being produced by a test. Did that remark refer merely to cord injuries in the war?

DR. CROTHERS: Many of the observations, such as sweating, are identical with those reported by Head and Riddoch on war cases of cord injury.

A considerable number of cases occurred in small premature babies. This is presumably accounted for by the fragility of the premature baby. I have seen no relation between cords around the neck and the injuries described in this paper. I am quite aware that sensory tests are difficult in babies and unquestionably we missed all but gross changes.

In general, the diagnosis of cord lesions depends on association of sensory and motor signs. In this group we have a few cases in which flaccid paralysis and total anesthesia leave no question that severe injury of the spinal cord has occurred. In others, less definite, it is quite possible that the brain rather than the cord is affected. However, we have followed some of these less dramatic cases for several years and have been able to prove that some, at least, were cord cases.

What we hope to prove, by detailed report of these cases, is that brachial palsy is not always an isolated condition, but that the unphysiologic force that produces the plexus injury frequently injures the central nervous system as well. If this can be proved, it will support our feeling that traction in obstetrics is not only unphysiologic but dangerous.

MONGOLIAN IMBECILITY AS AN ANTHROPOLOGIC PROBLEM. Presented by DR. CHARLES HERRMAN.

There is no positive evidence that worry, illness during pregnancy or congenital syphilis are essential factors in the causation of Mongolian imbecility. The condition is probably due to the presence of recessive unit factors. A recessive unit factor may reappear in a descendant after remaining latent for many generations. Defective embryos are the least likely to reach maturity. This is probably due to the presence of so-called "lethal factors," which cause a disintegration of the fertilized ovum. Many of the congenital anomalies which are often present in Mongolian imbeciles are definitely known to be due to the presence of recessive unit factors. As there have been several invasions of Eastern Europe by Mongols, there is probably an infusion of Mongolian blood in a certain number of Europeans. Although there are a few points of difference between Mongolian imbeciles and racial Mongols of low intelligence, there are so many features which they have in common, that it is not unlikely that there is an anthropologic relation. There are several points of resemblance between Mongolian imbeciles and the anthropoids, but there does not seem to be conclusive evidence that they are more closely related to the orang-utan than to the other anthropoids. Both the anthropoid and the Mongolian characteristics or unit factors must have been present in the parent trunk from which the human and anthropoid branches were derived. If we assume that Mongolian imbecility represents a reversion to a primitive type, we have a plausible explanation for the presence of certain anthropoid and certain Mongolian characteristics, for it is not surprising that occasionally a combination of these unit factors should appear in a descendant.

ACRODYNIA. Presented by DR. F. C. RODDA. Published in the August issue.

DISCUSSION

DR. HELMHOLZ: I would like to report on two cases of acrodynia. The first was an infant, aged about 8 months. I should like to call attention to the fact that there was a history of constant nasal discharge and of pneumonia. At necropsy, marked involvement of the paranasal sinuses was found. In the second case there was no apparent infections of the sinuses or tonsils, but knowing of Dr. Rodda's excellent results following tonsillectomy, the tonsils were removed. The child showed no improvement after the operation and the extreme irritability and tremendous itching continued. The child died suddenly two weeks later. No adequate cause of death was found. No anatomic changes were found in the brain, but there were definite changes in the nerves.

DR. ABT: If we concede that there is a focus of infection in the tonsil, in the sinuses or in some other region, how shall we explain the trophic symptoms? Does the infection produce a multiple neuritis or are we possibly dealing with a condition of the central nervous system, such as occurs in syringomyelia with the disturbances of sensation, alterations in the perception of heat and cold and other trophic phenomena? Careful studies of the peripheral nerves and of the central nervous system by a skilled neuropathologist might shed some light on this obscure disorder.

DR. BLACKFAN: What have you found in regard to the spinal fluid in these cases? We have had three patients in which pathologic changes were found in the spinal fluid. In one there was an increased number of cells and positive globulin, and in two there was a definite increase in the amount of globulin present. In one patient who came to necropsy there were histologic evidences like that reported in encephalitis, and an extensive lymphoid infiltration in other organs of the body.

DR. HESS: A patient with this disease entered the Cook County Hospital. The case was interesting because of the typical clinical picture, the rapid

course, and evident relationship between these and the focal infection. The infant presented the typical clinical picture of acrodynia, including the loss of the two lower incisors. The child was over 2 years of age. The intern had diagnosed meningitis, and was preparing to do a spinal puncture because of the presence of a retracted head. On further examination the thyroid was found to be enlarged and sensitive. The child had acute thyroiditis. During the examination of the throat, we found a punched out ulcer on the posterior wall of the pharynx. We cleaned out the slough and found that it went down to the vertebra. There was a bulging in the superior mediastinal notch. The child was transferred to the surgical service and died during the night. Necropsy showed a mediastinal abscess containing 2 ounces of pus.

To sum up: This child had three weeks previously developed an upper respiratory tract infection followed by an ulceration of the pharynx; the infection traveled down to the mediastinum, involving the thyroid, the acuteness of the course undoubtedly being due to the overpowering infection.

DR. HEIMAN: How do you explain the absence of the disease in the East? I have never seen a case in New York and we have never seen one in our institution.

DR. FLEISCHNER: Has there been any special bacteriologic examination made of the tonsils removed from these patients? It would seem that if the etiologic agent were in the tonsils, some effort should be made to study the pathology and bacteriology of the tonsils in this condition.

DR. HOWLAND: This disease is not entirely absent from the East. In all, I have seen five cases; one child had gangrene of the toes. I saw her again ten years afterward and she was entirely well. In one fatal case we had the opportunity to make a pathologic examination. There were no changes in the cord or brain and a study of the nerves was very disappointing. There were a few changes, but they were not sufficient to warrant a diagnosis of peripheral neuritis.

DR. RUHRÄH: Have you any differential blood counts in these cases?

DR. RODDA: In the patients referred to no infection of the sinuses was found, though such infections might readily occur as a factor in acrodynia. The spinal fluid was examined in a few cases, but nothing characteristic was found. Nothing distinctive was found in the differential blood count.

There is nothing new in these case reports, which are typical. My reason for presenting them was to call attention to the prevalence of the disease and to the fact that if we recognize the cases early and remove the foci of infection, we may expect much better results than have been attained in the past.

SOME SPECTROSCOPIC OBSERVATIONS ON COD LIVER OIL. Presented by DR. FREDERIC W. SCHLUTZ and DR. M. MORSE (by invitation). Published in the August issue.

DISCUSSION

DR. KRAMER: This interesting paper suggests several questions. First, what evidence is there that this particular residue was really antirachitic? I say this because it is possible to extract cod liver oil by the procedure described by Zucker and others. One may obtain an extract that has all the physical properties of an active product and yet is wholly inert, and second, one might raise the question as to whether the changes observed in the absorption spectrum are merely accidental or are intimately associated with the antirachitic properties of the substance.

DR. SCHLUTZ: In answer to Dr. Kramer's remarks, I can only say that we accepted the statement of Dr. Zucker that the third fraction of the cod liver oil from which the cholesterol had been removed was antirachitic and did not question his experimental results. Both Dr. Hess and Dr. Steenbach are very modest about giving details of their experimental work. We had a good deal of difficulty with some of the technical phases of our research. We, for example, had a good deal of difficulty in finding a suitable spark. The iron spark does

not give a satisfactory spectrum. The spectrum of the aluminum spark also shows many bad spots. At the suggestion of Dr. Tate of the physics department we are now using a tungsten spark under water. The question of a suitable solvent for our solutions also gave us some difficulty. We found, for example, that absolute alcohol absorbed the region in which the cholesterol bands showed up. Ether dried over calcium chlorid and distilled gave us the best results. It also seemed to us that it was hardly safe to trust the naked eye in determining the limits of absorption. With the use of the precision photodensitometer it is possible to determine these much more accurately than with the naked eye.

EXPERIENCES WITH THE DICK TEST IN INFANTS AND CHILDREN. Presented by DR. ALFRED HAND and DR. JAMES J. REILLY (by invitation).

An extensive epidemic of scarlet fever visited Philadelphia in the winter of 1924-1925, affording an opportunity of using the Dick test and observing its relation to the disease. The number of our cases is very small compared to the figures given by Zingher (*International Clinics*, **3**, [Sept.] 1924), but it is of interest to note that our results agree perfectly with the conclusions given by the Dicks, Zingher and others.

In the Children's Hospital of Philadelphia, there arose in the course of about two months sixteen cases of scarlet fever, eight of the patients being nurses. Seventy-six of the hospital patients were tested with the Dick scarlatinal toxin, thirty-three being positive and forty-three negative. None of those giving negative reactions developed scarlet fever, although all were probably exposed to it, as the nurses who contracted it were on general duty. Of the thirty-three showing positive tests, two came down with scarlet fever, a rather small number, but, to our minds, illustrating well the long-observed low degree of contagion or transmissibility of the disease. But of these thirty-one susceptible ones, eight were given injections of the antitoxic serum; seven of them gave negative Dick tests forty-eight hours later, one remaining positive, but none contracting the disease on definite contact.

An additional series of thirty-nine cases was observed by one of us (R.) through the courtesy of Dr. Lovett of the Camden, N. J., Bureau of Health. Twenty-four of these patients reacted positively to the Dick test and were given the antitoxic serum after exposure to scarlet fever, one of them developing the disease, the others being negative to the test subsequently. The remaining fifteen of the whole group gave negative reactions and were not given the antitoxic serum; all were exposed to scarlet fever but none contracted it.

Neonatal immunity is shown by the results in six infants under 8 days of age who were in Dr. Gittings' department in the University Hospital; five were negative and one was positive.

Through the kindness of Dr. S. S. Woody, thirty-four convalescents from scarlet fever were examined in the Philadelphia Hospital for Contagious Diseases; only one, who was in his fourth week with marked desquamation of the palms and soles, giving a positive reaction. This struck us as quite interesting, but recalled to mind that relapses and second attacks of scarlet fever have been reported in the literature. It is reasonable to infer that such patients would be apt to show positive reaction after the first attack. In making these tests one point worth mentioning as to the technic was observed; when old needles were used which had developed a little rust in the bore after the preceding use, the control would sometimes make more of a showing than the test, although all the needles and the syringes had been boiled for twenty minutes.

CONCLUSION

The behavior of the Dick test in 155 patients has removed any skepticism we may have had at the start as to the specific relationship of the toxin and the streptococci from which it was derived toward scarlet fever.

CHICAGO PEDIATRIC SOCIETY

May, 19, 1925

HENRY W. CHENEY, M.P., *President*

TREATMENT OF PERTUSSIS BY ROENTGEN RAY. Presented by DR. JULIUS H. HESS.

Dr. Hess reviewed the literature on this subject and gave tables illustrating his two groups of patients, who had received this treatment, a summer and fall group of 62, and a winter group of 40 cases. The following technic was used: with a 4 ma., using a 1 mm. aluminum filter and a 7 inch spark gap at a distance of 14 inches, a five minute exposure was made, the exception being in young infants when the first treatment at least was given for a shorter period, usually from two and one-half to three minutes. The treatment was given with the child lying on its back in the majority of cases. In no instance was the treatment repeated in less than five days, while in some the interval was as long as seven days.

The following conclusions were drawn:

1. Treatments should not be given before the paroxysmal stage is reached, since their chief function is to lessen the severity of the disease. In some cases there was a striking shortening of the course, which was of secondary importance.

2. In the summer and fall group, striking results were noted in 43 per cent., or twenty-seven of the sixty-two cases, and considerable improvement in an additional 34 per cent., or twenty-one cases. In ten of the twenty-seven cases only one treatment was required, in twelve, two treatments and in four cases three treatments. In the winter group there were fewer striking results, a total of 25 per cent. and an additional 27.5 per cent. with general improvement. Of the ten showing striking improvement one patient received one treatment, three patients received two treatments and six received three treatments.

3. In six cases of secondary pneumonia, there was general improvement after roentgenotherapy.

4. Excessive exposure of young children is dangerous. The neighboring organs should be protected and only a minimum number of exposures should be given.

Dr. Hess recommended that the results, both immediate and remote, of roentgenotherapy in whooping cough be further studied before suggesting the method for general use. The adoption of this method as a routine treatment would require a change in quarantine regulations in most cities.

DISCUSSION

DR. CLIFFORD G. GRULEE: The psychic element in these cases was very noticeable, particularly in the prolongation of the cough. He said he had had little experience with whooping cough but that in a series of cases complicated by pneumonia he had used mixed vaccine and had excellent results as patients recovered, though one died later with recurrent pneumonia.

DR. HENRY W. CHENEY: He had been talking with various roentgen-ray men, and their testimony bore out Dr. Hess' results.

DR. STANLEY GIBSON: A child with severe whooping cough, who vomited everything and who was slowly starving to death, in the fourth week was given roentgen-ray treatments. A miraculous change took place as the vomiting immediately ceased, as did the paroxysms.

DR. JULIUS H. HESS: He did not believe that the roentgen ray did any good before the whooping cough was in the paroxysmal stage, as its greatest benefit was in checking the vomiting and relieving the paroxysms. The season of the year appeared to be important. They had followed their cases as carefully as possible with blood counts, roentgen-ray examination, cards and letters for from two to three months, and they believed that the course was often not shortened by the roentgenotherapy; its greatest effect was relief of symptoms. It was not a "cure all" but he believed it had its place in selected cases.

Book Reviews

PHYSIOLOGY AND PATHOLOGY OF THE INFANT'S STOMACH. By S. ROSENBAUM, Berlin: Verlag von S. Karger, 1925.

This treatise constitutes one of the supplements of the *Jahrbuch für Kinderheilkunde*. The author gives an extensive review of the literature on all phases of the subject, with a complete bibliography.

APPROACHING MOTHERHOOD. By GEORGE L. BRODHEAD, M.D. Price, $1.25. Pp. 181. New York: Paul B. Hoeber, Inc., 1925.

This little manual, written for the enlightenment of the expectant mother, is intended to convey the information which will be most useful to her during pregnancy, supplementing the advice she will receive from time to time from her own physician. The subject matter, which is conveyed in the form of question and answer, covers in a simple way the essential anatomy, the general physiology and the signs of pregnancy, the estimation of the date of confinement, the how and why of visiting the physician, accidents and discomforts of pregnancy, its complications, popular fallacies, the general hygiene and diet, preparations for and the conduct of confinement, convalescence, and the early care and nursing of the baby. There are convenient blank pages on which to jot down such other questions as the reader may wish to ask her physician.

We fancy that there will be few to cavil at the information thus given. The statements and the simple rules given are such as would be made by any experienced and conservative obstetrician, and we believe this little book may well serve the purpose of making pregnancy lighter for many readers. From the standpoint of the pediatrician, the emphasis on breast feeding, and the suggestions toward the preparation for it, are especially to be appreciated.

If there is any criticism of the book, it is in the occasional obtrusion of an insufficiently explained scientific word, which might puzzle some readers. For the most part, when used, such words are adequately defined.

The book is nicely finished, and the good paper and bold, clear type enhance the reader's comfort.

A STUDY OF SLEEP IN CHILDREN. By PAUL KARGER. Berlin: Verlag von S. Karger, 1925.

Karger studied various phases of sleep in children, with special reference to activity during sleep. He employed an apparatus registering movements of the child, the apparatus being attached to the bed. In order to make a record of all movements of the child, he put one foot of the bed on a piece of rubber, 2 cm. in height, the child being unaware of the experiment.

The resulting record he terms "aktogramm." He studied about 300 children, varying in age from 2½ to 12½ years. He aimed to study normal children, but none of his children were entirely normal, as all of them suffered from some disturbance for which they were brought to the hospital.

He found that in addition to variations in depth, sleep manifests variations due to movement or activity of the child, the sleep, however, being uninterrupted during this activity. He found also that the activity during sleep varies in the same child from night to night; this inconstancy of course making the interpretation of his experiments less valuable.

When sleep is once interrupted, the sleep that follows is less quiet than previously.

Sleep depends a good deal on the temperament of the child. The more intelligent the child the more pronounced the activity during sleep. Idiots manifest their agility even during sleep. Home work, playing and story telling in the evening lead to an increased activity the first hours of sleep. Changes in light and heat have no influence; medication given for the purpose of inducing sleep does not produce any change in activity if given in therapeutic doses; if overdoses are given, activity is lessened; bromids, however, do lessen activity even in usual doses. Phenobarbital produces a decreased narcotic action the next night. Atropin and caffeine produce marked restlessness the first few hours of the night. Fever shows no increased activity even when produced artificially. Hunger reduces activity; rich food increases it.

In encephalitis lethargica (epidemic encephalitis) there is marked restlessness in sleep of even moderate depth. This restlessness recedes with the improvement of the patient. The author found no special characteristic activity in nocturnal epilepsy.